NOTES, UNLESS OTHERWISE SPECIFIED:

1. RESISTANCE VALUES IN OHMS.

2. CAPACTITANCE VALUES IN MICROFARADS.

3. REFERENCE DESIGNATORS USED:

4. ALL 0.1 uF AND 0.01uF CAPACITORS ARE DECOUPLING CAPS UNLESS OTHERWISE NOTED. THEY ARE SHOWN ON THE PAGE WITH THE INTEGRATED CIRCUITS THEY SHOULD BE PLACED NEAR.

5. NHET1xx means NHET1_[xx].

6. OBSERVE THE LAYOUT NOTES IN SCHEMATIC.

Changes on RevC:

1. Changed SD card slot
2. R291 and R293 value for Gladiator 1.2V core power
3. Route EMIF D[8:15] to exp connector (missed on RevB)

Changes on RevD:

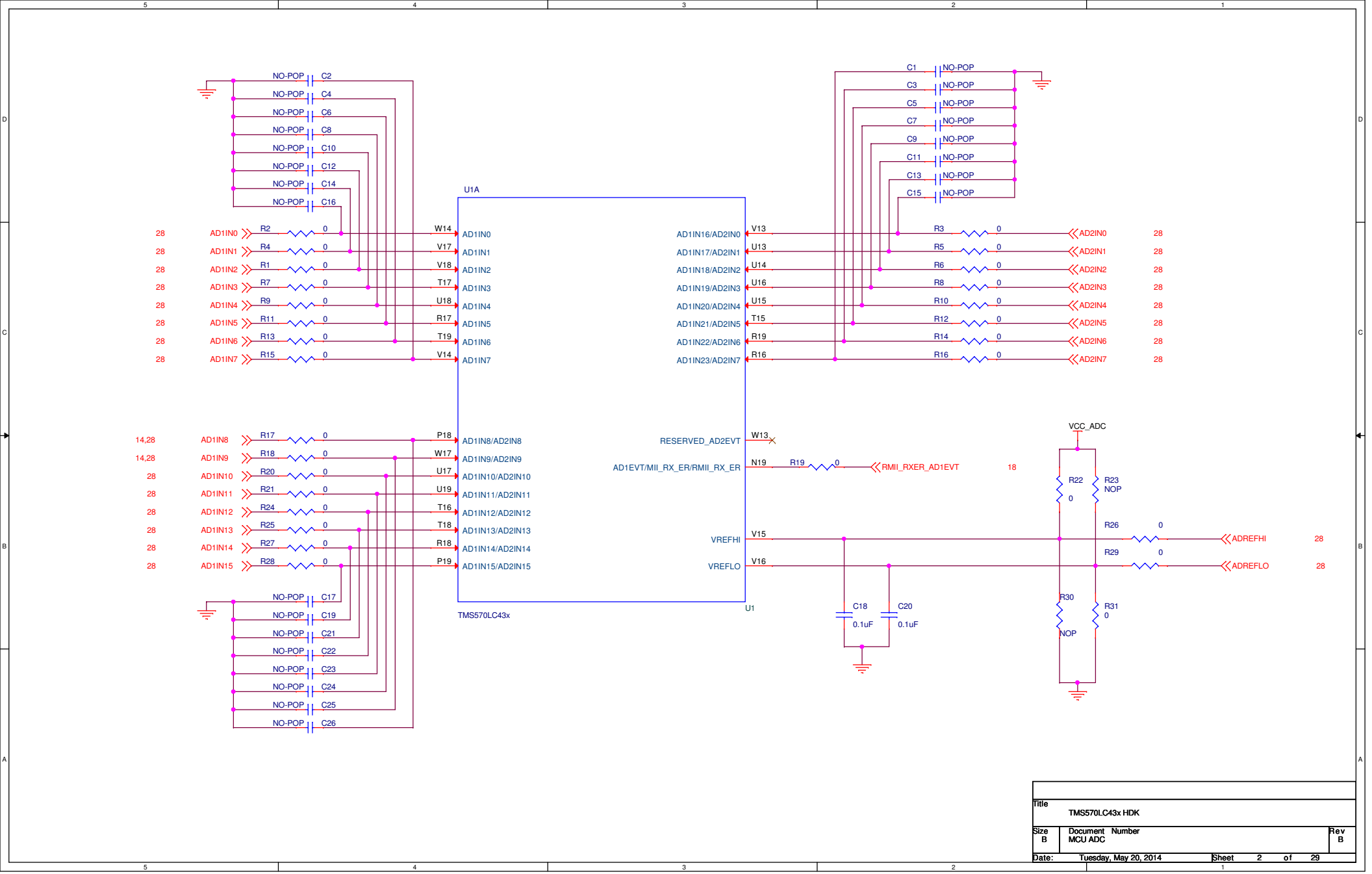
1. Added n_channel FET and RC to JTAG nTRST (P07)

Changes on RevE:

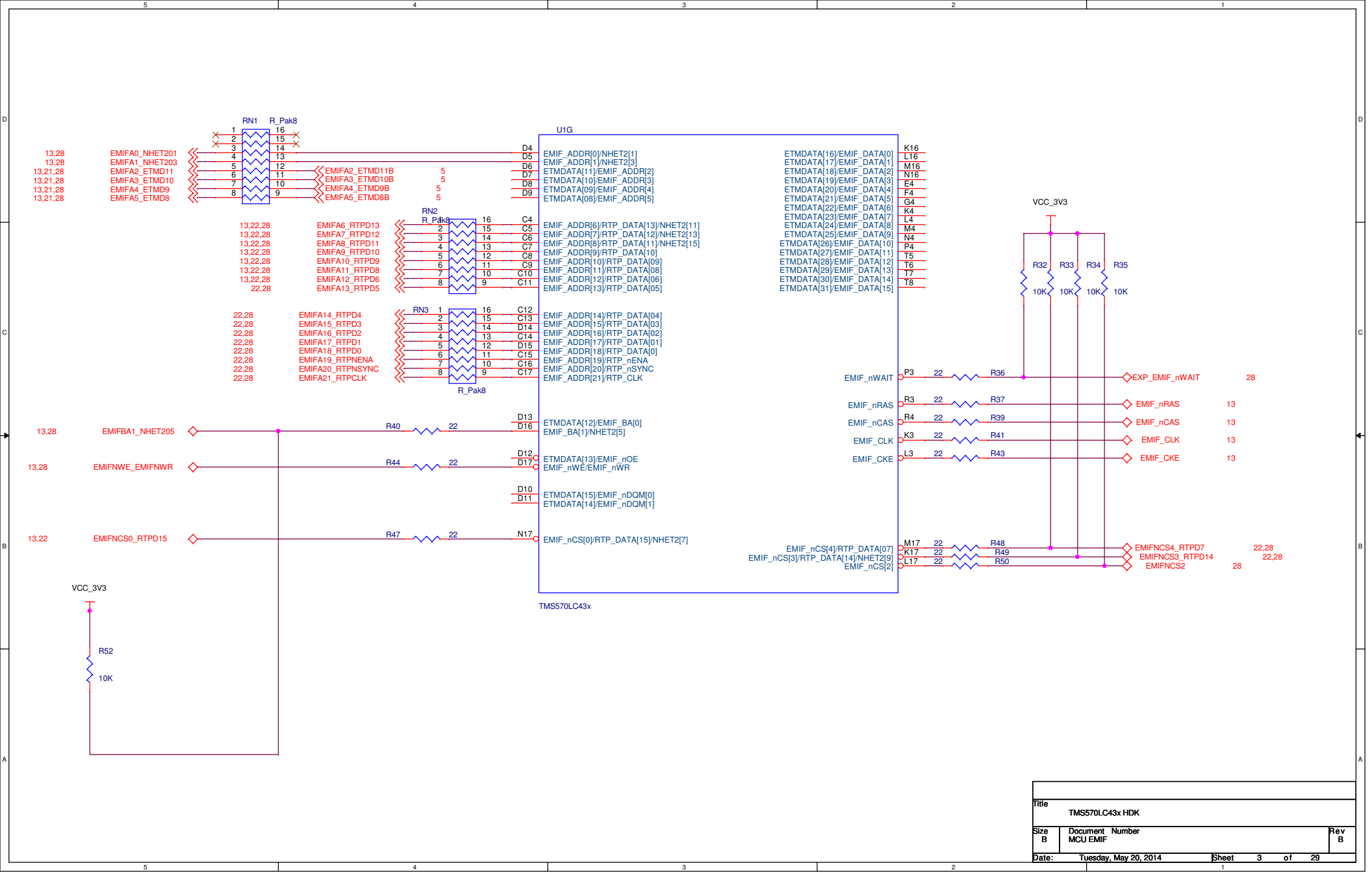
1. Added n_channel FET and RC to JTAG nTRST (P07)
2. Replaced 2 color LEDs with 2 white LEDs

SCHEMATIC CONTENTS

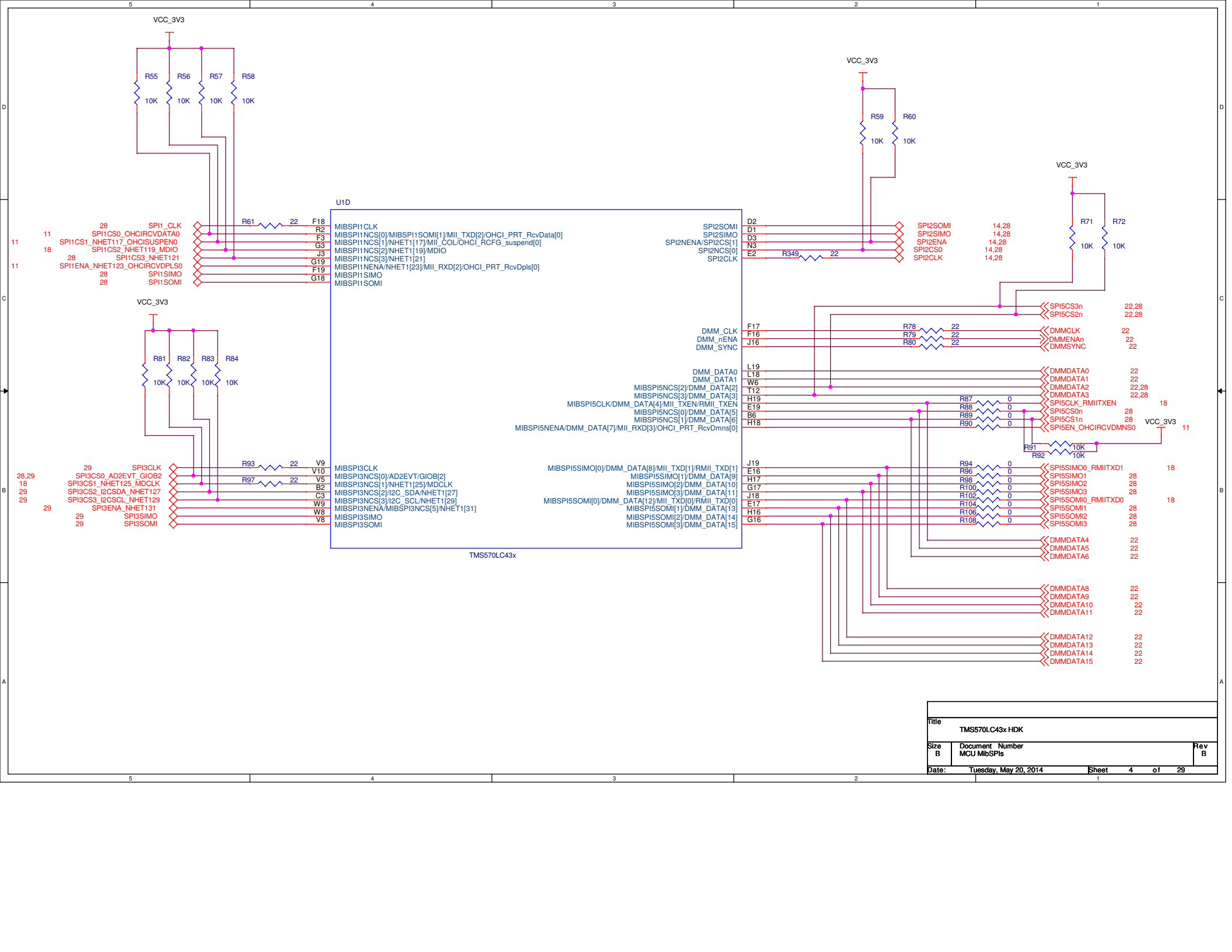
Texas Instruments Inc		
Title: TMS570LC43x HDK		
Size: A	Document Number: TITLE	Rev: B
Date: Tuesday, May 20, 2014	Sheet 1 of 29	

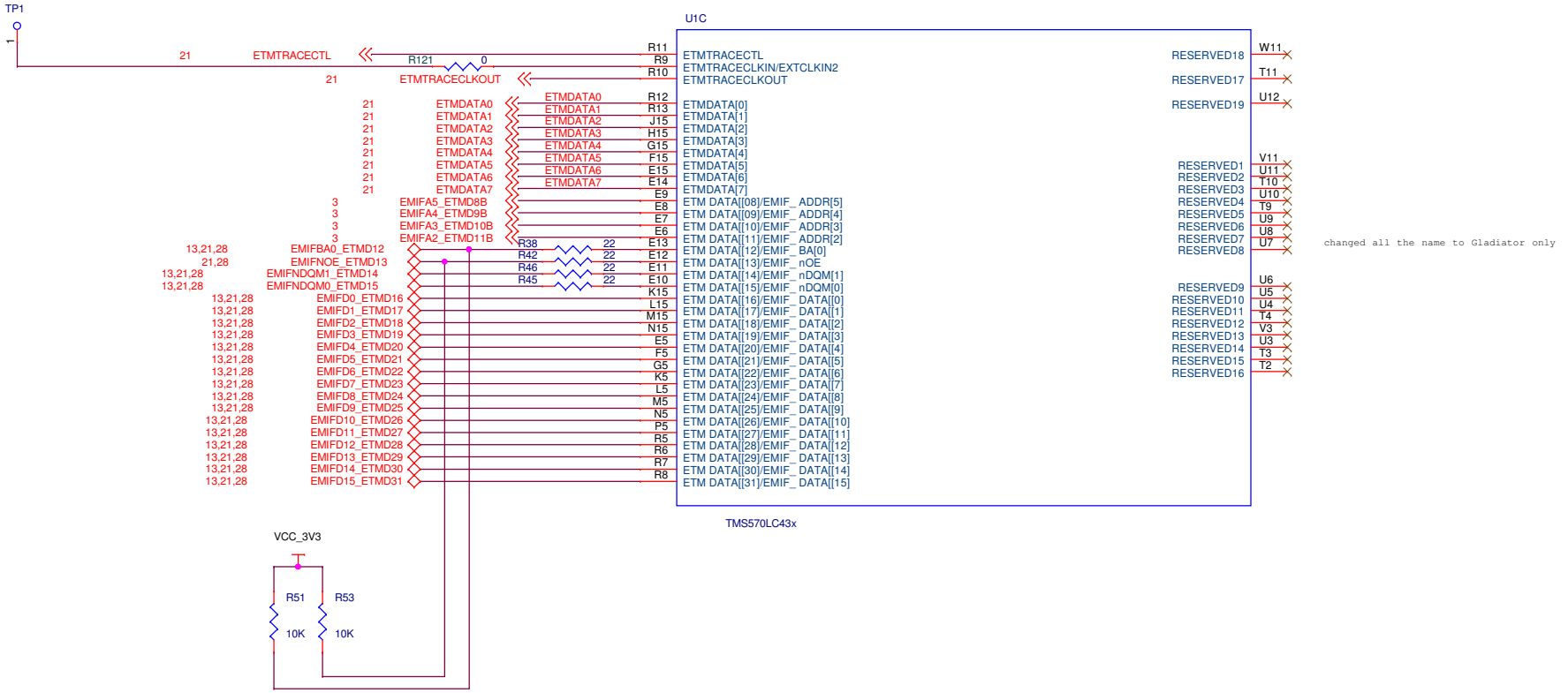


Title	TMS570LC43x HDK	
Size B	Document Number MCU ADC	Rev B
Date: Tuesday, May 20, 2014	Sheet 2 of 29	

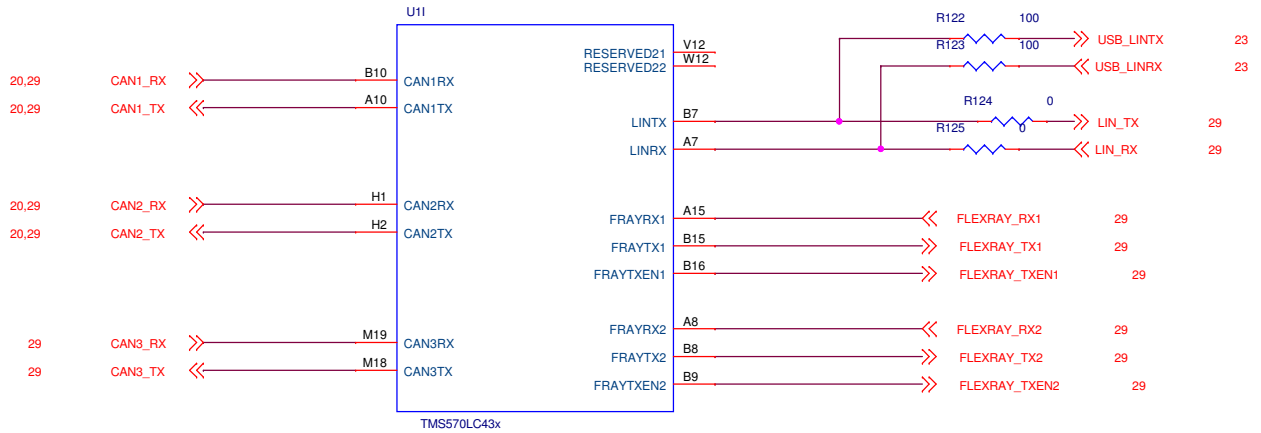


Title	TMS570LC43x HDK	
Size B	Document Number MCU EMIF	Rev B
Date: Tuesday, May 20, 2014	Sheet 3 of 29	

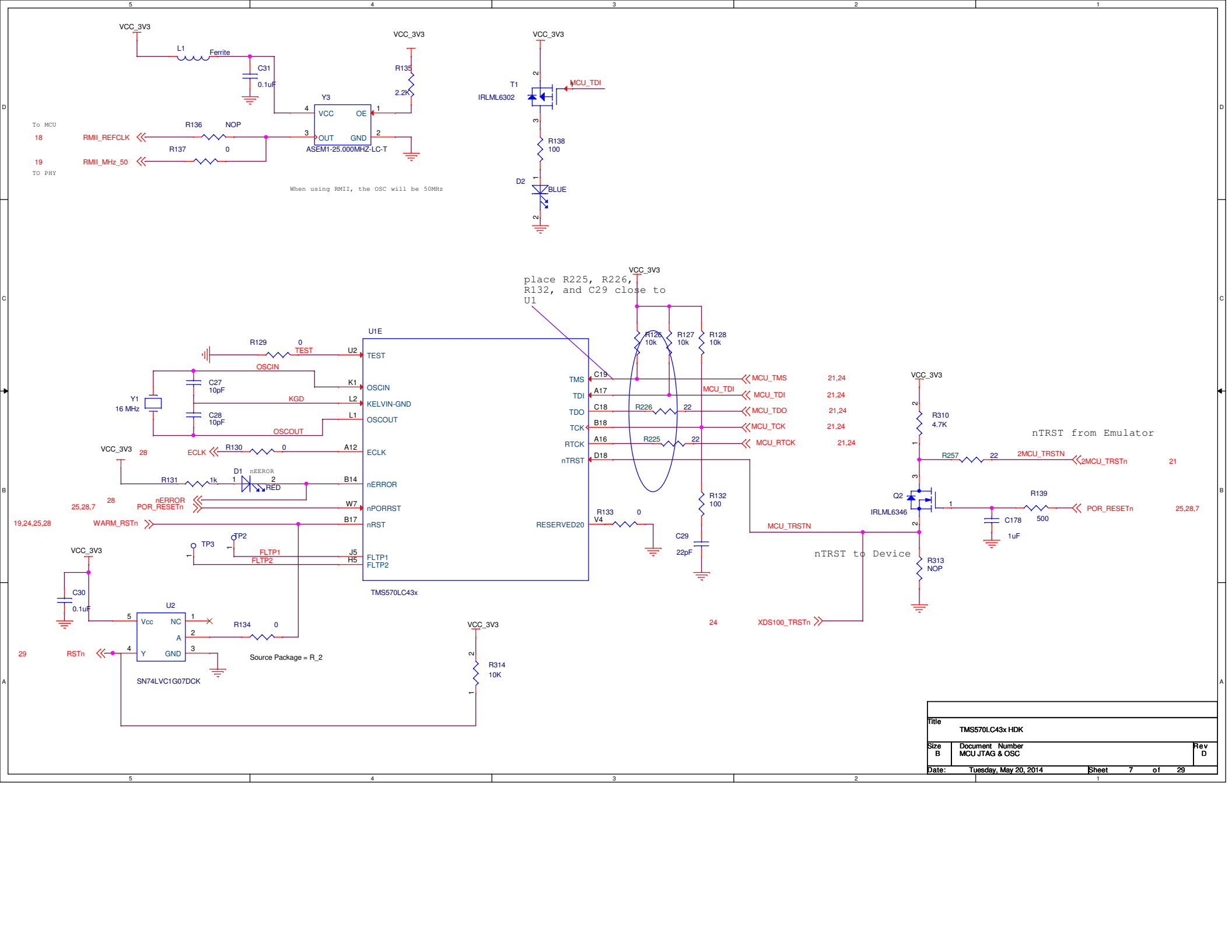

VCC_3V3
R55 R56 R57 R58
10K 10K 10K 10K
U1D
28 SPI1_CLK
11 SPI1CS0_OHCIRCVDATA0
11 SPI1CS1_NHET117_OHCISUSPEN0
18 SPI1CS2_NHET119_MDIO
28 SPI1CS3_NHET121
11 SPI1ENA_NHET123_OHCIRCVDPLS0
28 SPI1SIMO
28 SPI1SOMI
R61 22
F18 MIBSPI1CLK
R2 MIBSPI1NCS[0]/MIBSPI1SOMI[1]/MII_TXD[2]/OHCI_PRT_RcvData[0]
F3 MIBSPI1NCS[1]/NHET1[17]/MII_COL/OHCI_RCFG_suspend[0]
G3 MIBSPI1NCS[2]/NHET1[19]/MDIO
J3 MIBSPI1NCS[3]/NHET1[21]
G19 MIBSPI1NENA/NHET1[23]/MII_RXD[2]/OHCI_PRT_RcvDpls[0]
F19 MIBSPI1SIMO
G18 MIBSPI1SOMI
VCC_3V3
R81 R82 R83 R84
10K 10K 10K 10K
29 SPI3CLK
28,29 SPI3CS0_AD2EVT_GIOB2
18 SPI3CS1_NHET125_MDCLK
29 SPI3CS2_I2CSDA_NHET127
29 SPI3CS3_I2CSCL_NHET129
29 SPI3ENA_NHET131
29 SPI3SIMO
29 SPI3SOMI
R93 22
R97 22
V9 MIBSPI3CLK
V10 MIBSPI3NCS[0]/AD2EVT/GIOB[2]
V5 MIBSPI3NCS[1]/NHET1[25]/MDCLK
B2 MIBSPI3NCS[2]/I2C_SDA/NHET1[27]
C3 MIBSPI3NCS[3]/I2C_SCL/NHET1[29]
W9 MIBSPI3NENA/MIBSPI3NCS[5]/NHET1[31]
W8 MIBSPI3SIMO
V8 MIBSPI3SOMI
TMS570LC43x
SPI2SOMI D2
SPI2SIMO D1
SPI2NENA/SPI2CS[1] D3
SPI2NCS[0] N3
SPI2CLK E2
R349 22
SPI2SOMI 14,28
SPI2SIMO 14,28
SPI2ENA 14,28
SPI2CS0 14,28
SPI2CLK 14,28
VCC_3V3
R59 R60
10K 10K
VCC_3V3
R71 R72
10K 10K
DMM_CLK F17
DMM_nENA F16
DMM_SYNC J16
R78 22
R79 22
R80 22
DMMCLK 22
DMMENAn 22
DMMSYNC 22
SPI5CS3n 22,28
SPI5CS2n 22,28
DMM_DATA0 L19
DMM_DATA1 L18
MIBSPI5NCS[2]/DMM_DATA[2] W6
MIBSPI5NCS[3]/DMM_DATA[3] T12
MIBSPI5CLK/DMM_DATA[4]/MII_TXEN/RMII_TXEN H19
MIBSPI5NCS[0]/DMM_DATA[5] E19
MIBSPI5NCS[1]/DMM_DATA[6] B6
MIBSPI5NENA/DMM_DATA[7]/MII_RXD[3]/OHCI_PRT_RcvDmns[0] H18
R87 0
R88 0
R89 0
R90 0
DMMDATA0 22
DMMDATA1 22
DMMDATA2 22,28
DMMDATA3 22,28
SPI5CLK_RMIITXEN 18
SPI5CS0n 28
SPI5CS1n 28
SPI5EN_OHCIRCVDMNS0 VCC_3V3 11
R91 10K
R92 10K
MIBSPI5SIMO[0]/DMM_DATA[8]/MII_TXD[1]/RMII_TXD[1] J19
MIBSPI5SIMO[1]/DMM_DATA[9] E16
MIBSPI5SIMO[2]/DMM_DATA[10] H17
MIBSPI5SIMO[3]/DMM_DATA[11] G17
MIBSPI5SOMI[0]/DMM_DATA[12]/MII_TXD[0]/RMII_TXD[0] J18
MIBSPI5SOMI[1]/DMM_DATA[13] E17
MIBSPI5SOMI[2]/DMM_DATA[14] H16
MIBSPI5SOMI[3]/DMM_DATA[15] G16
R94 0
R96 0
R98 0
R100 0
R102 0
R104 0
R106 0
R108 0
SPI5SIMO0_RMIITXD1 18
SPI5SIMO1 28
SPI5SIMO2 28
SPI5SIMO3 28
SPI5SOMI0_RMIITXD0 18
SPI5SOMI1 28
SPI5SOMI2 28
SPI5SOMI3 28
DMMDATA4 22
DMMDATA5 22
DMMDATA6 22
DMMDATA8 22
DMMDATA9 22
DMMDATA10 22
DMMDATA11 22
DMMDATA12 22
DMMDATA13 22
DMMDATA14 22
DMMDATA15 22
Title
TMS570LC43x HDK
Size B
Document Number
MCU MibSPIs
Rev B
Date: Tuesday, May 20, 2014
Sheet 4 of 29



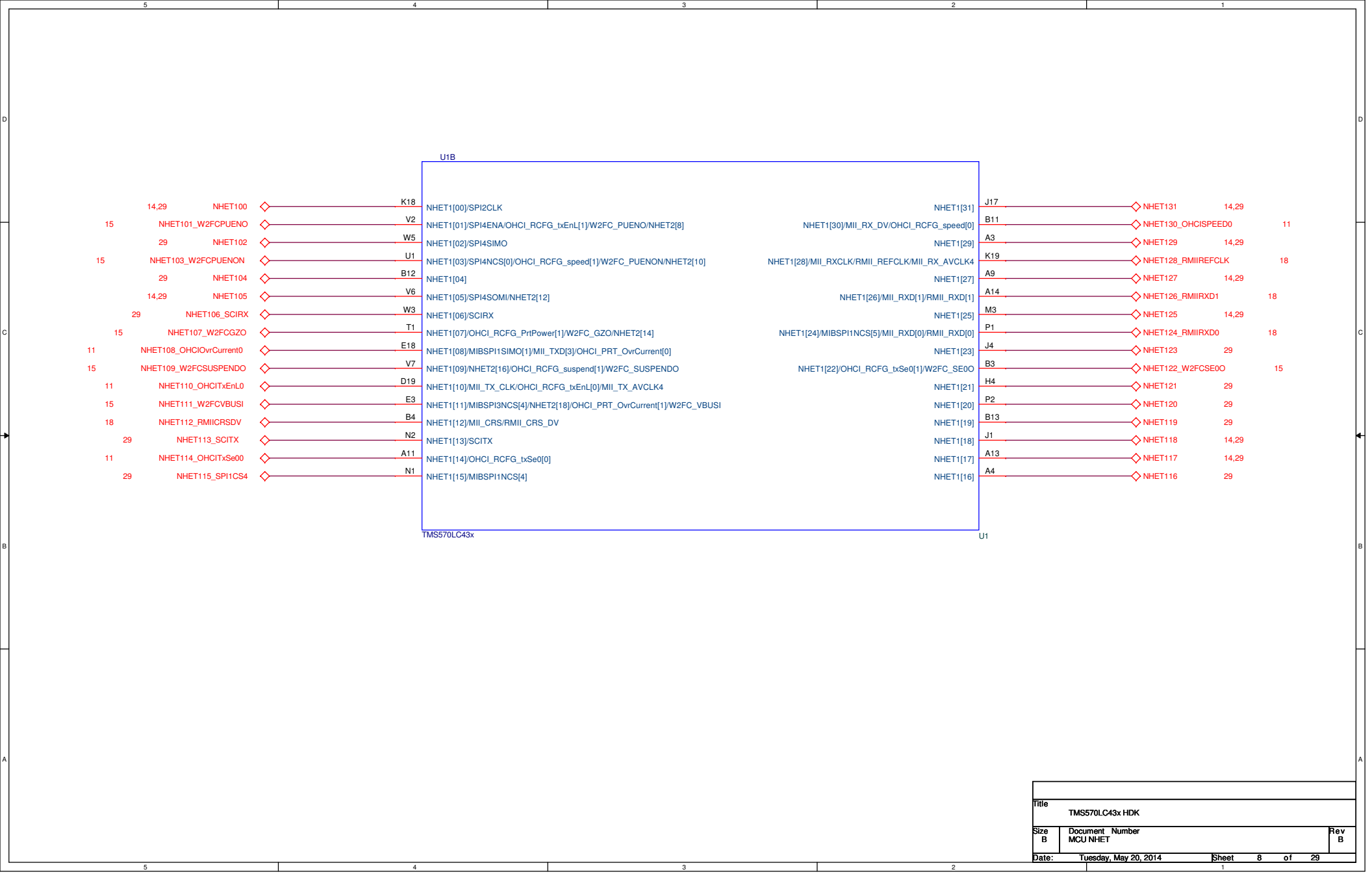
Title	TMS570LC43x HDK	
Size B	Document Number MCU ETM & Rsved RTP	Rev B
Date: Tuesday, May 20, 2014	Sheet 5 of 29	



Title	TMS570LC43x HDK	
Size B	Document Number MCU DCAN, FRAY, LIN	Rev D
Date: Tuesday, May 20, 2014	Sheet 6 of 29	

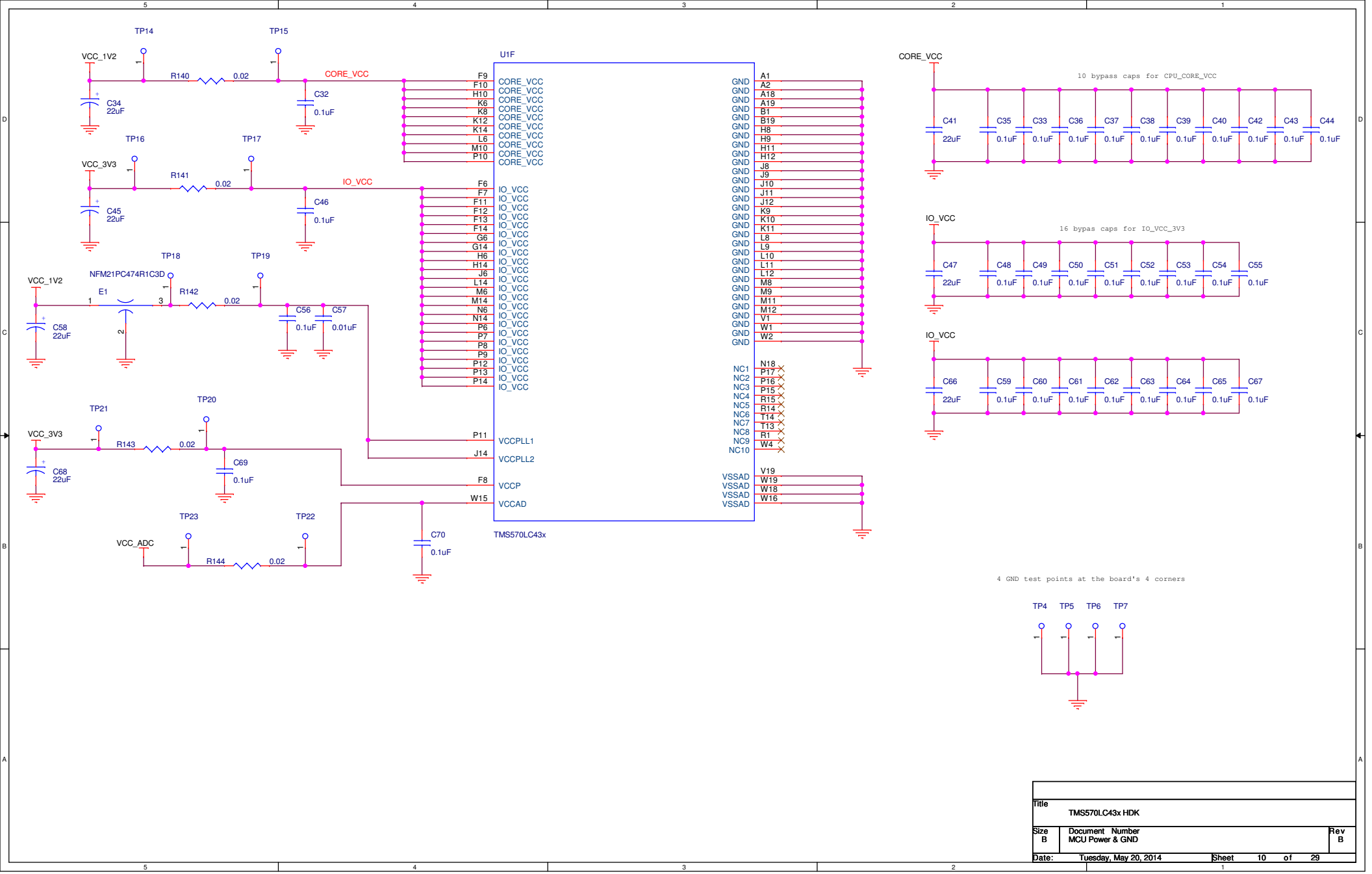


Title	TMS570LC43x HDK	
Size B	Document Number MCU JTAG & OSC	Rev D
Date: Tuesday, May 20, 2014	Sheet 7 of 29	

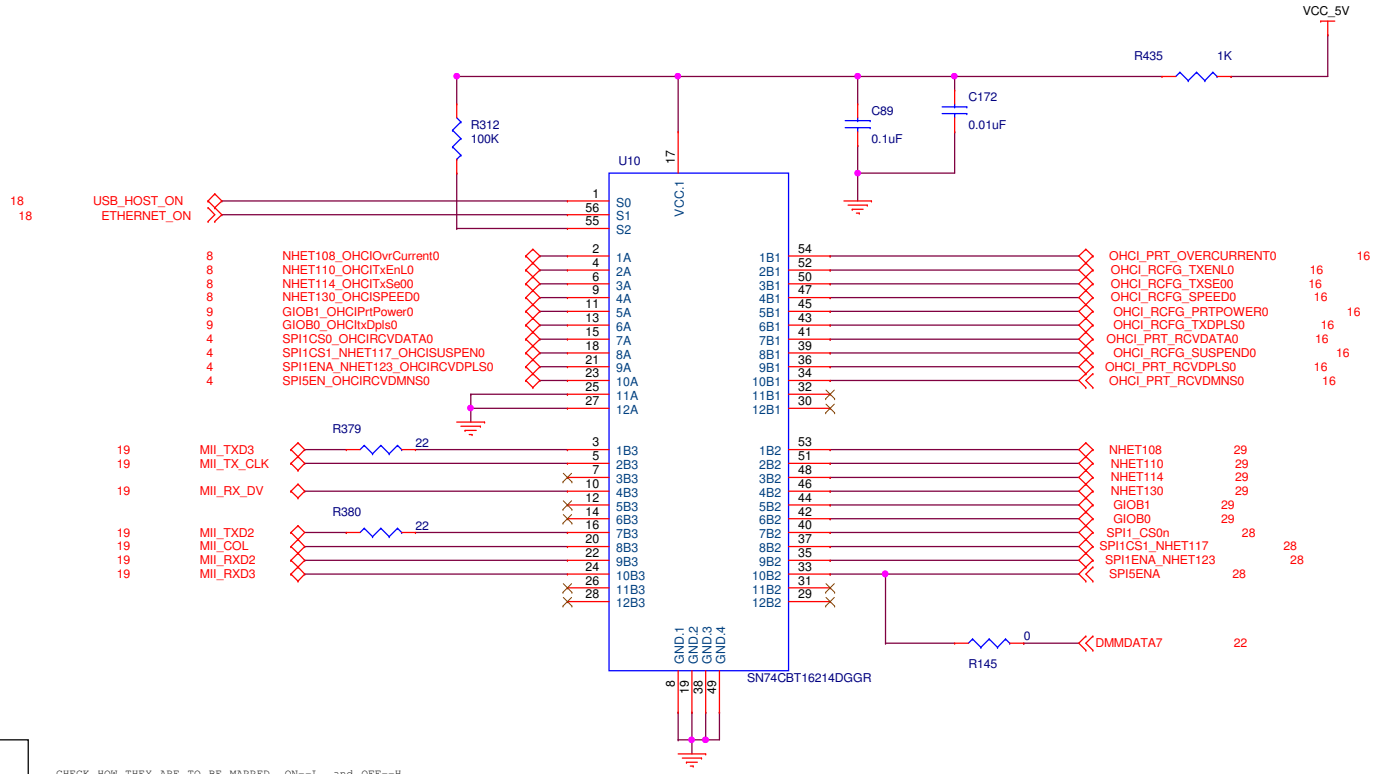


Title	TMS570LC43x HDK	
Size B	Document Number MCU NHET	Rev B
Date: Tuesday, May 20, 2014	Sheet 8 of 29	

Title	TMS570LC43x HDK	
Size B	Document Number MCU GPIO	Rev B
Date: Tuesday, May 20, 2014	Sheet 9 of 29	



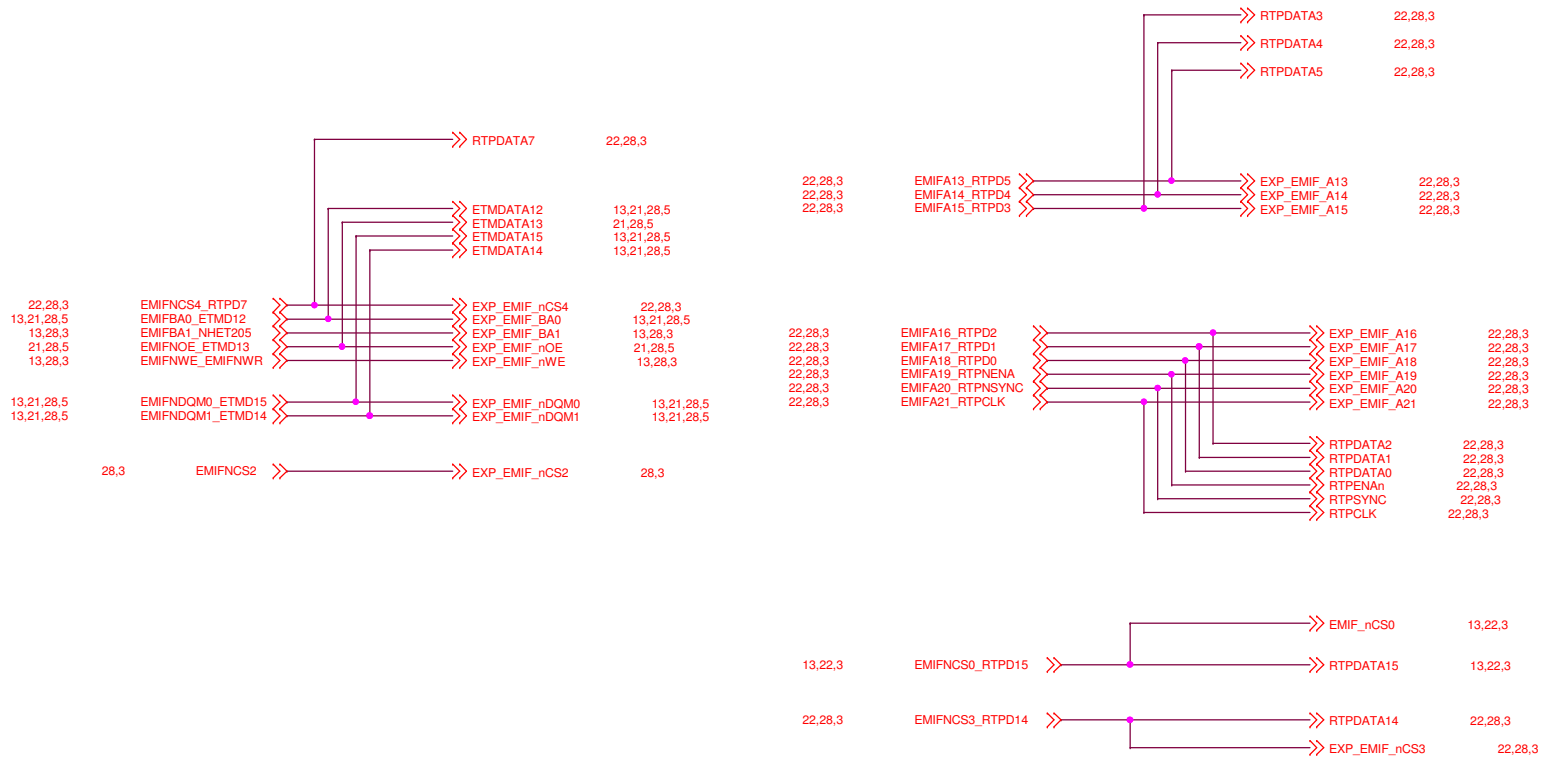
Title	TMS570LC43x HDK	
Size B	Document Number MCU Power & GND	Rev B
Date: Tuesday, May 20, 2014	Sheet 10 of 29	



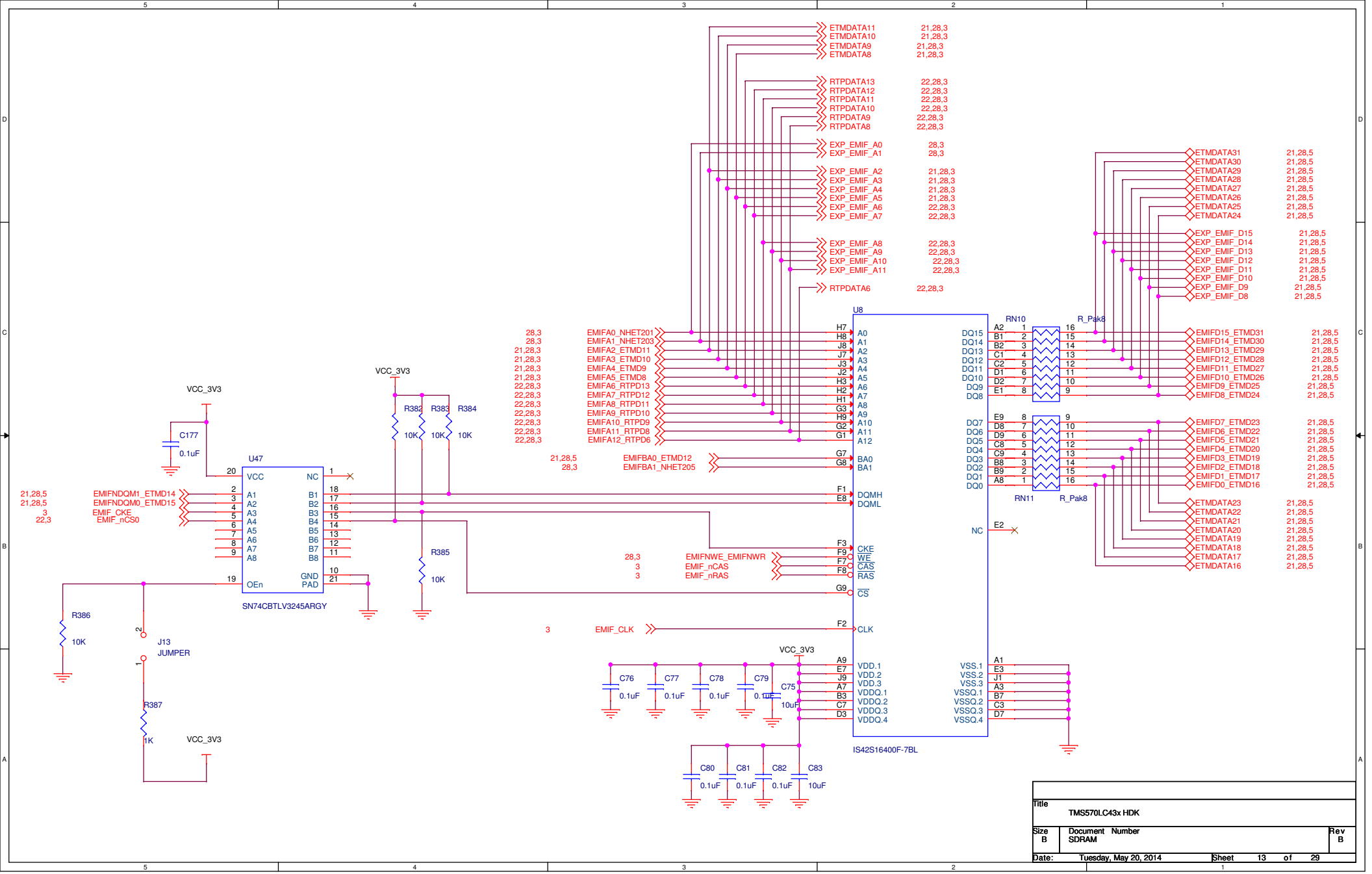
S2	S1	S0	A
1	0	0	Z
1	0	1	B3**
1	1	0	B1 **
1	1	1	B2 **

CHECK HOW THEY ARE TO BE MAPPED. ON--L, and OFF--H

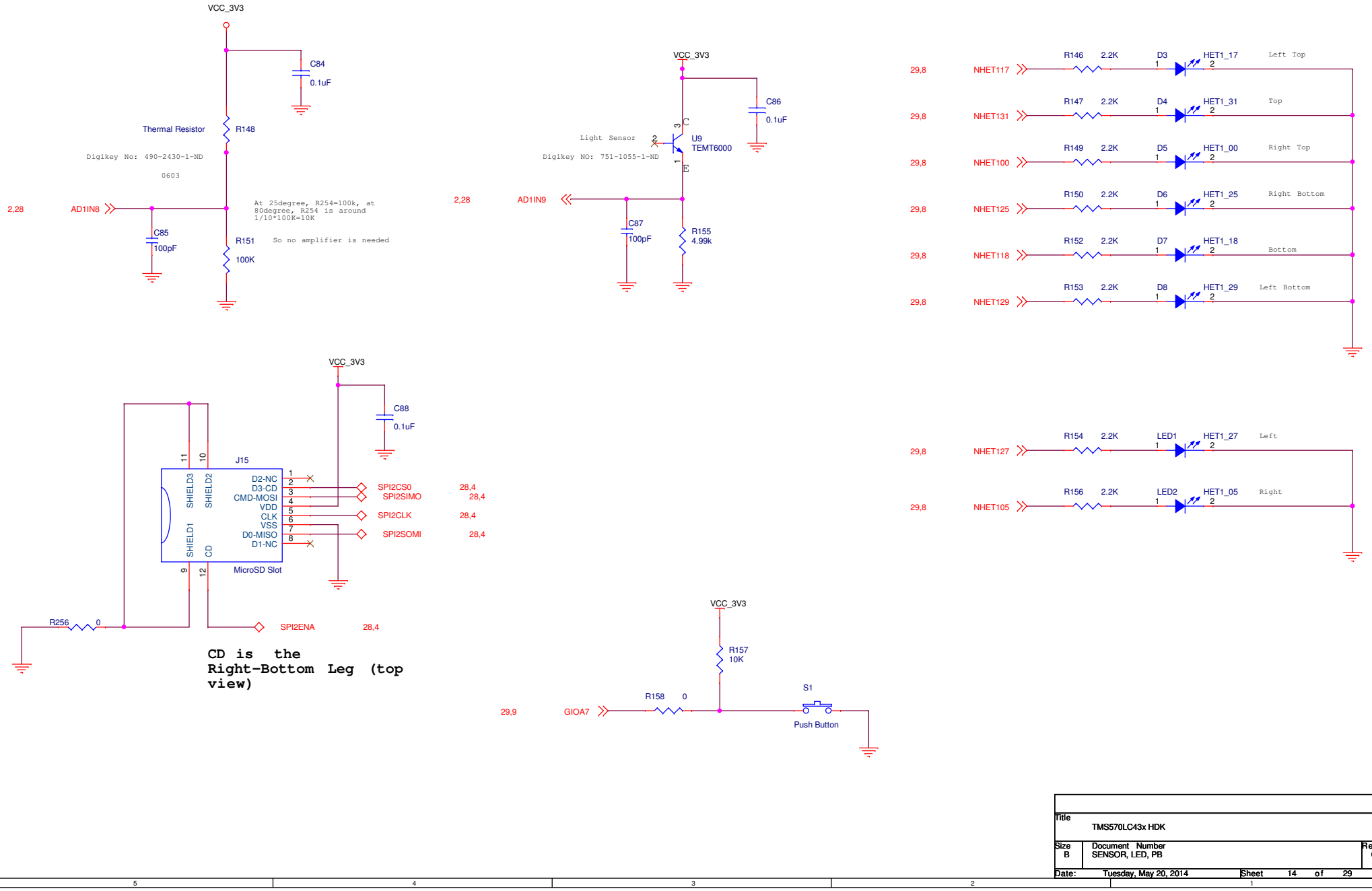
Title: TMS570LC43x HDK		
Size: B	Document Number: FET SWs FOR 1st USB HOST	Rev: B
Date: Tuesday, May 20, 2014	Sheet 11 of 29	



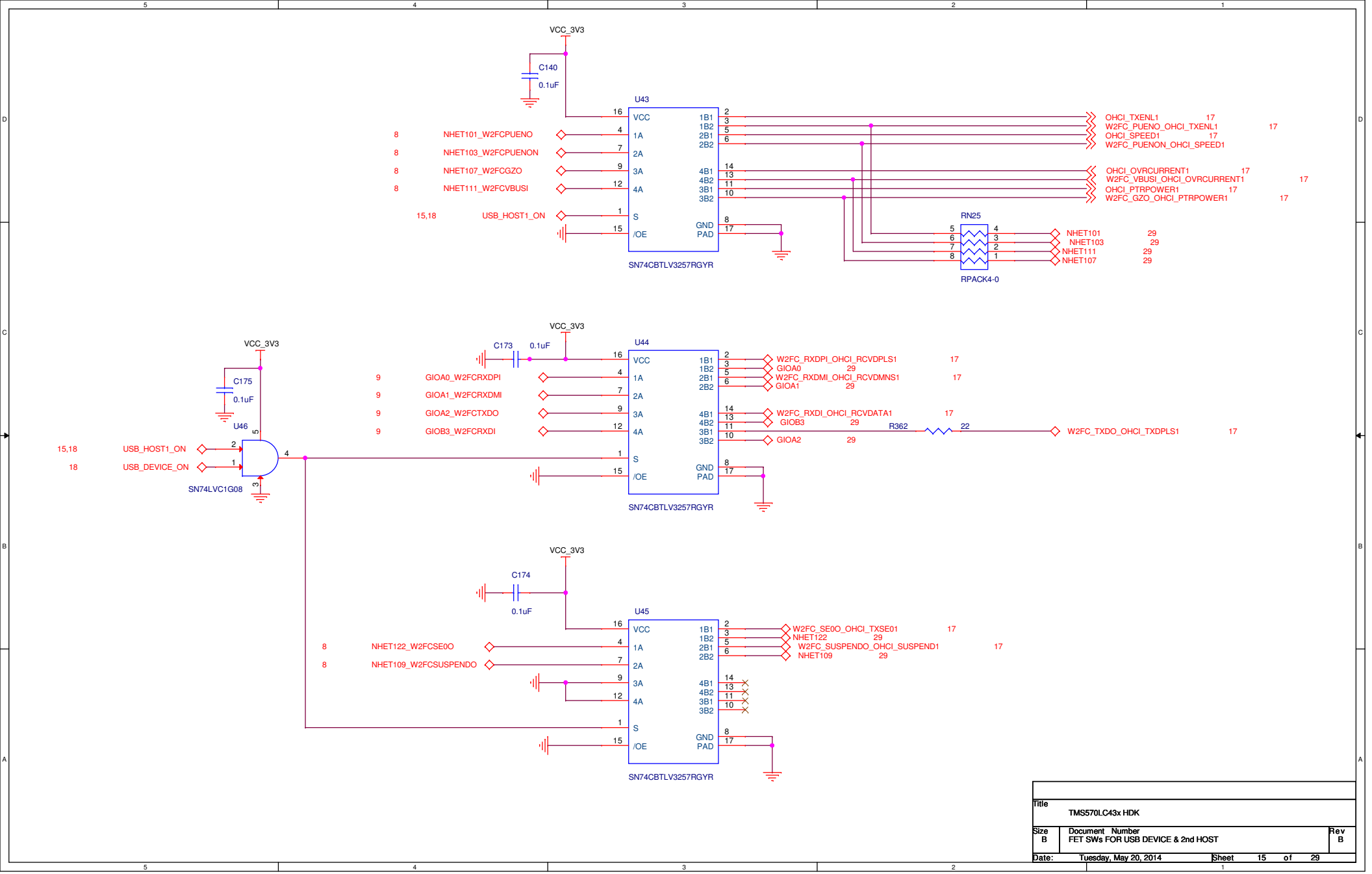
Title	TMS570LC43x HDK	
Size B	Document Number EMIF DATA and ADDR BUSES	Rev B
Date: Tuesday, May 20, 2014	Sheet 12 of 29	



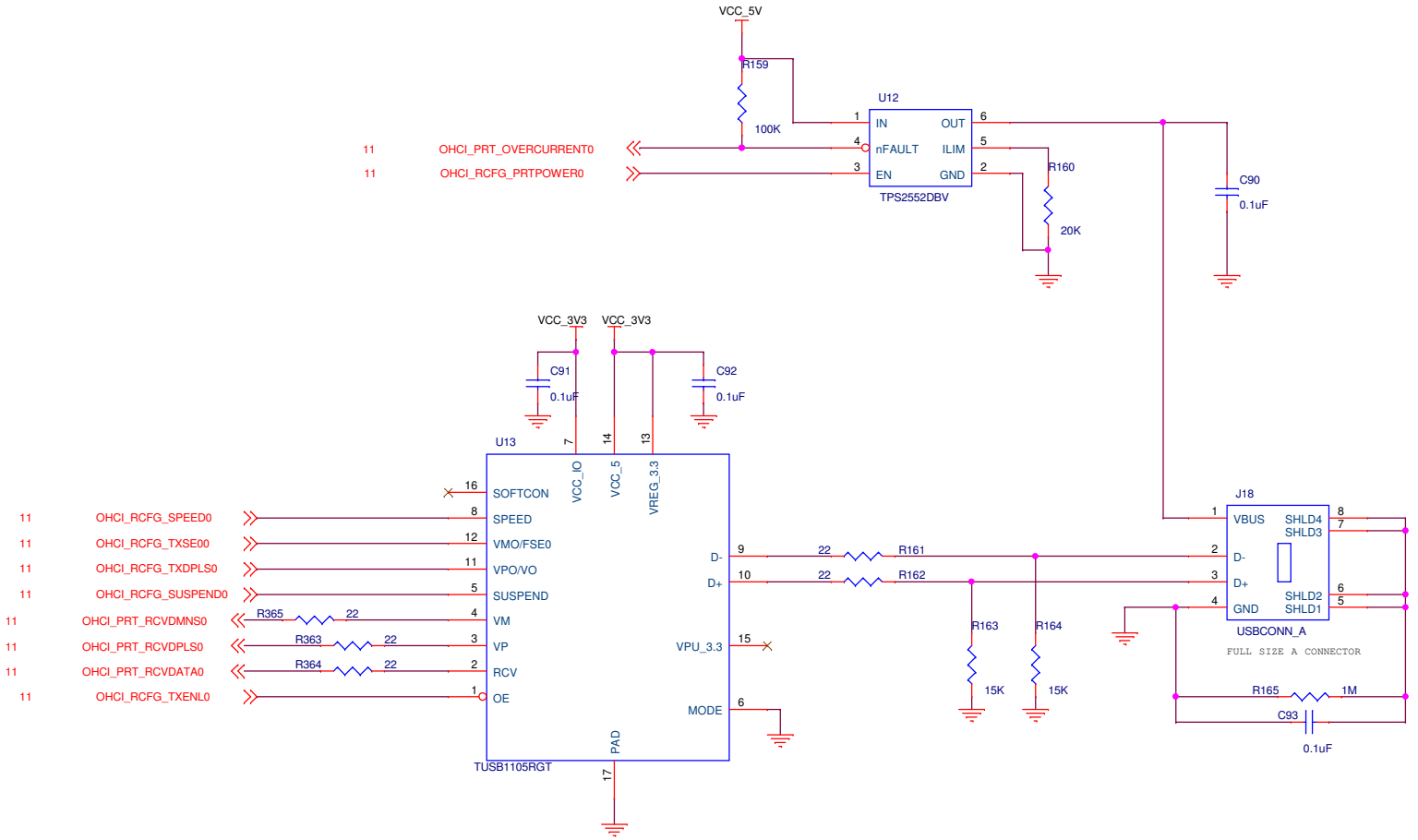
Title	TMS570LC43x HDK	
Size B	Document Number SDRAM	Rev B
Date: Tuesday, May 20, 2014	Sheet 13 of 29	



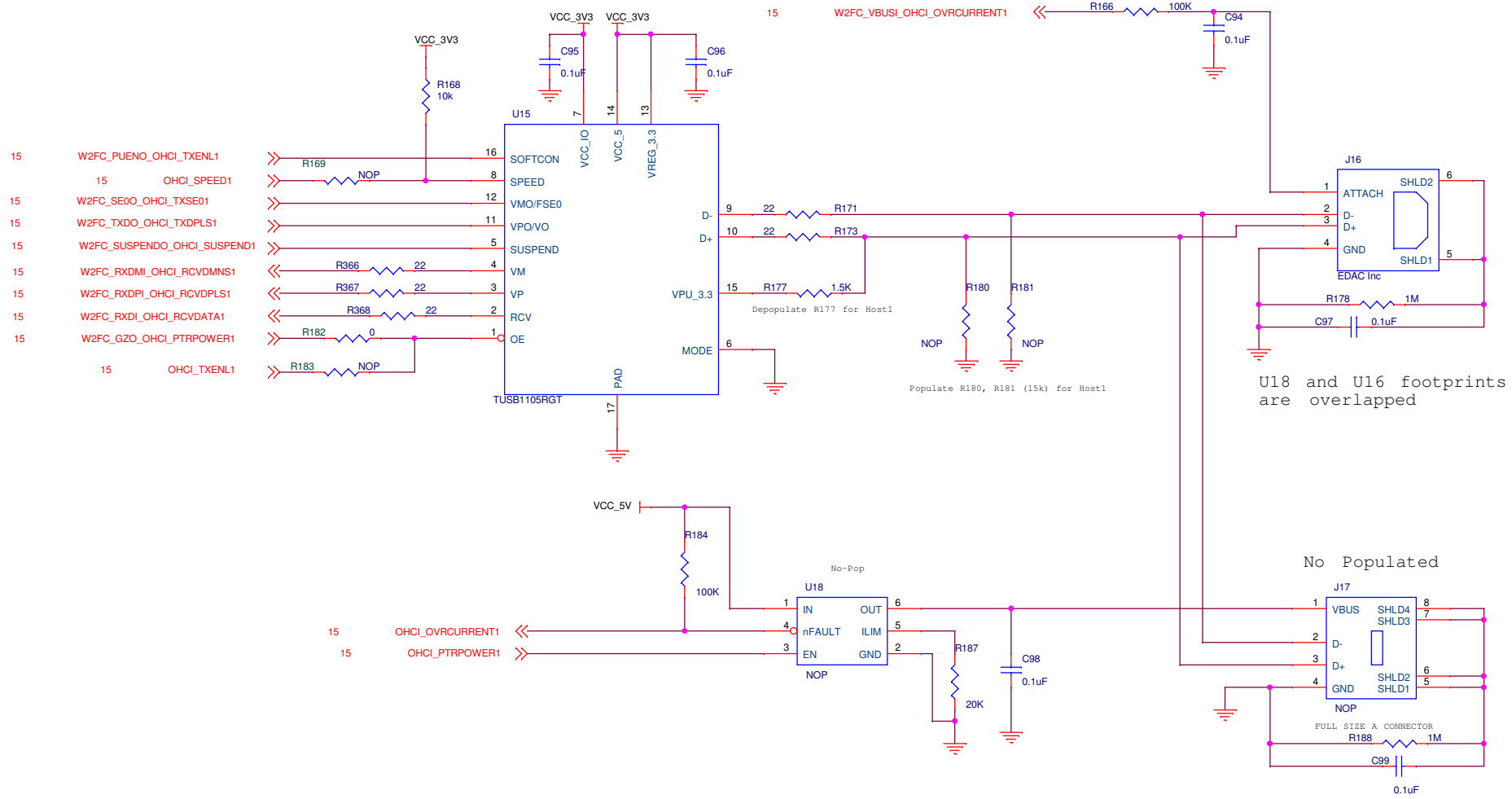
Title	TMS570LC43x HDK	
Size B	Document Number SENSOR, LED, PB	Rev C
Date: Tuesday, May 20, 2014	Sheet 14 of 29	



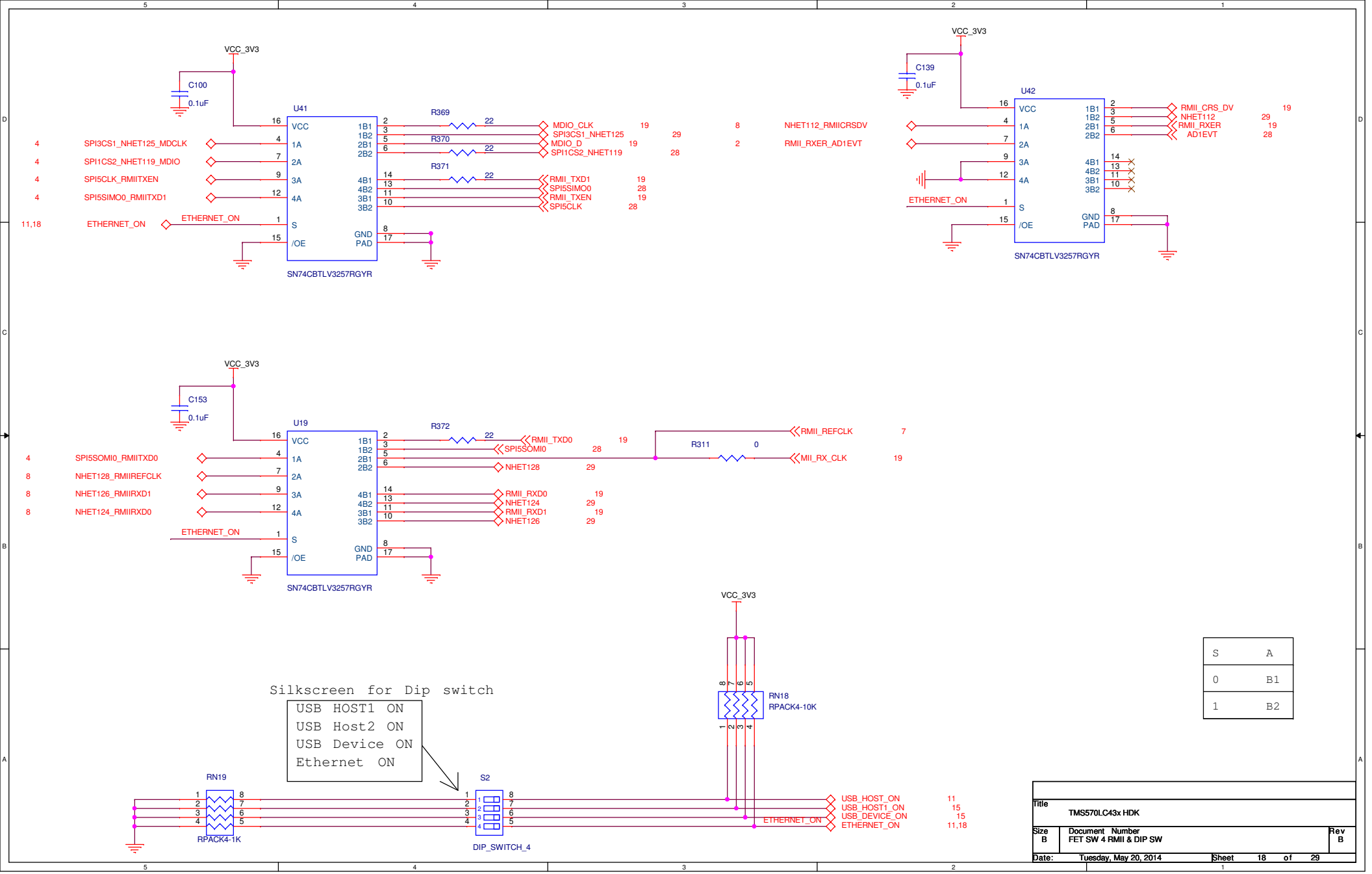
Title	TMS570LC43x HDK	
Size B	Document Number FET SWs FOR USB DEVICE & 2nd HOST	Rev B
Date: Tuesday, May 20, 2014	Sheet 15 of 29	

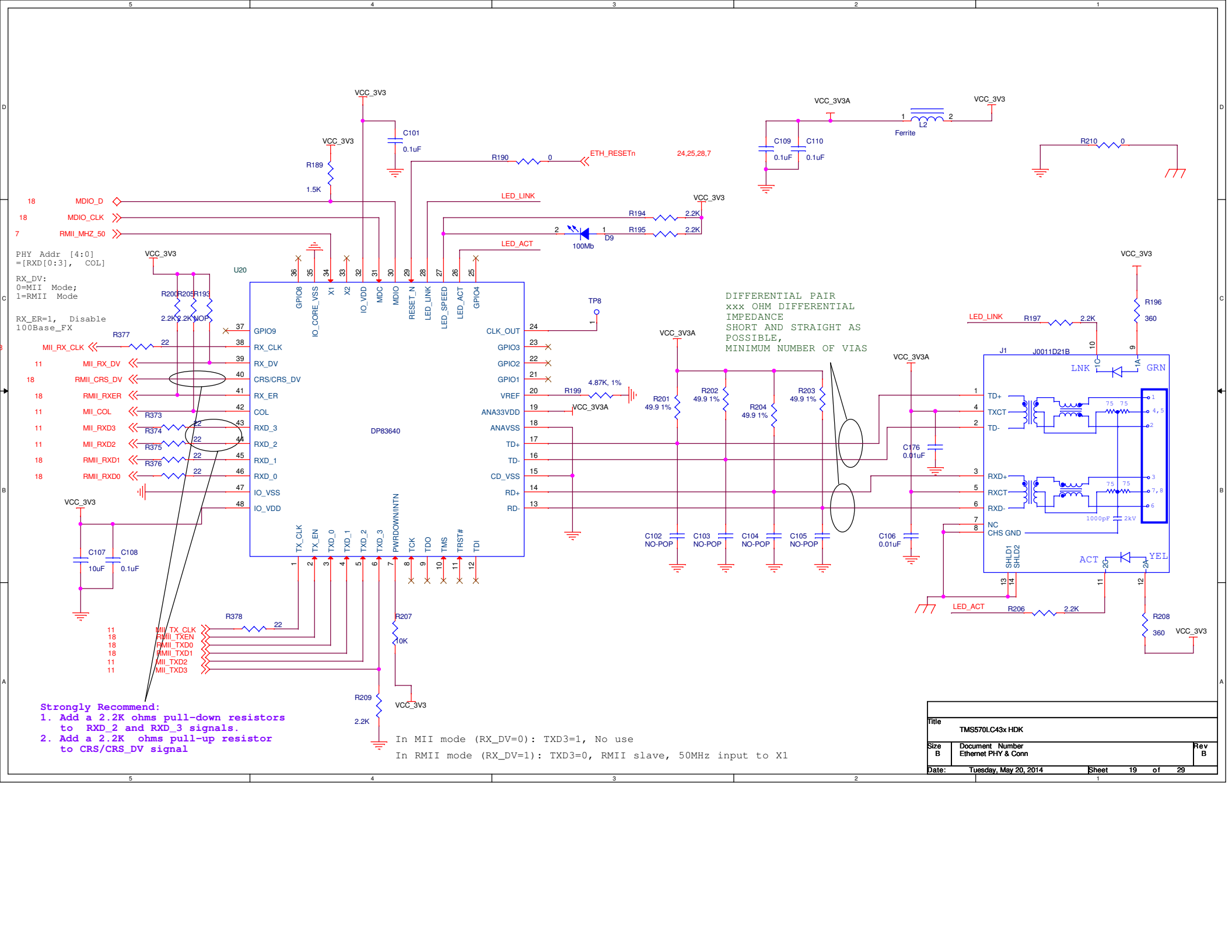


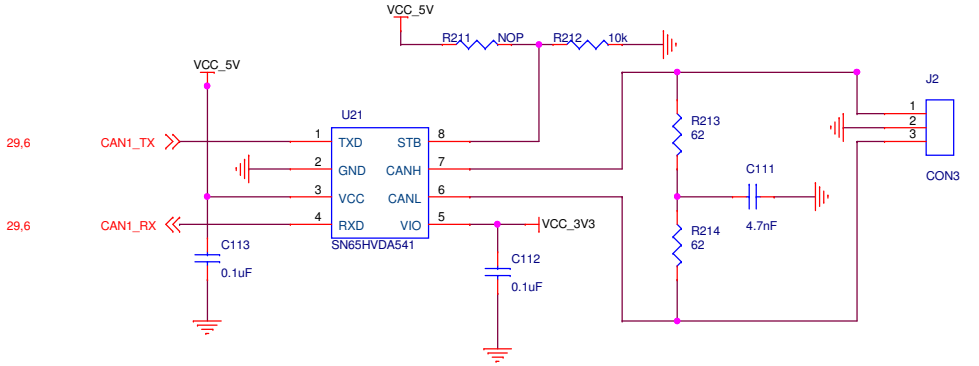
Title	TMS570LC43x HDK	
Size B	Document Number USB 1st OHCI Host	Rev B
Date: Tuesday, May 20, 2014	Sheet 16 of 29	

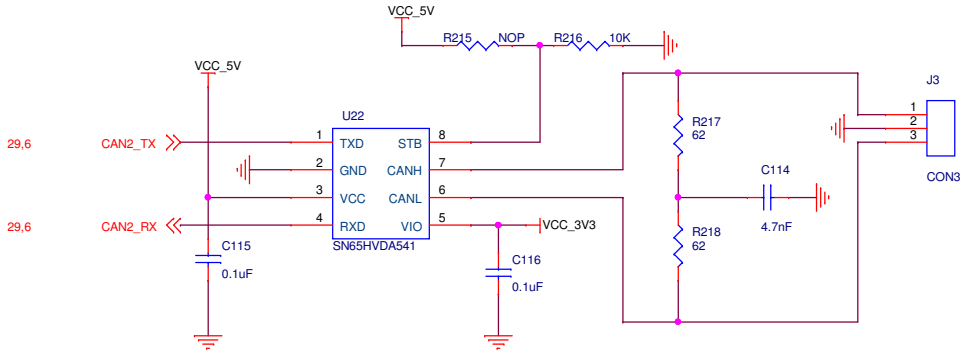


Title	TMS570LC43x HDK	
Size B	Document Number USB Device & 2nd HOST	Rev B
Date: Tuesday, May 20, 2014	Sheet 17 of 29	

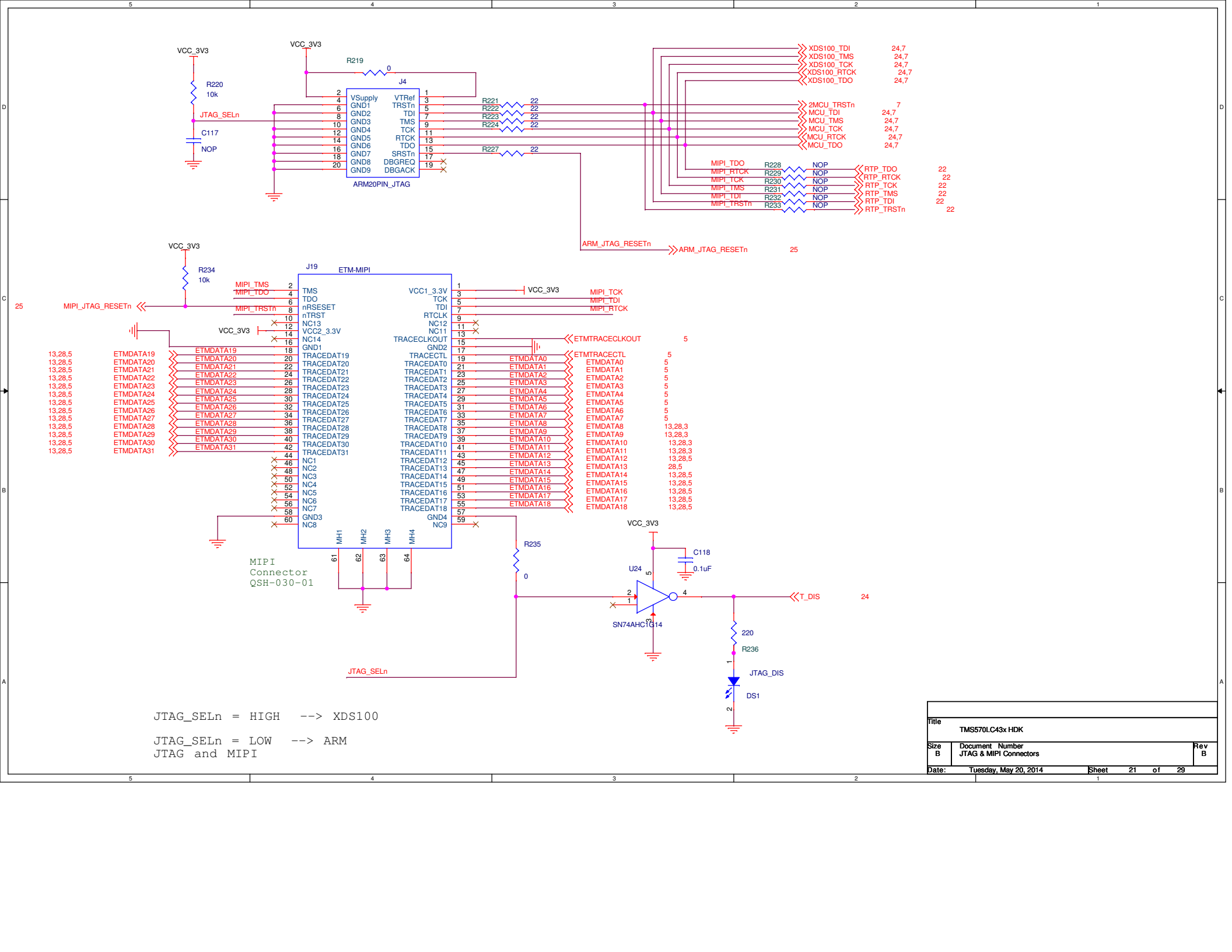

VCC_3V3
C100
0.1uF
U41
SN74CBTLV3257RGYR
R369
R370
R371
SPI3CS1_NHET125_MDCLK
SPI1CS2_NHET119_MDIO
SPI5CLK_RMIITXEN
SPI5SIMO0_RMIITXD1
ETHERNET_ON
MDIO_CLK
SPI3CS1_NHET125
MDIO_D
SPI1CS2_NHET119
RMII_TXD1
SPI5SIMO0
RMII_TXEN
SPI5CLK
C139
U42
RMII_CRS_DV
NHET112
RMII_RXER
AD1EVT
NHET112_RMIICRSDV
RMII_RXER_AD1EVT
C153
U19
R372
R311
SPI5SOMI0_RMIITXD0
NHET128_RMIIREFCLK
NHET126_RMIIRXD1
NHET124_RMIIRXD0
RMII_TXD0
SPI5SOMI0
NHET128
RMII_RXD0
NHET124
RMII_RXD1
NHET126
RMII_REFCLK
MII_RX_CLK
Silkscreen for Dip switch
USB HOST1 ON
USB Host2 ON
USB Device ON
Ethernet ON
RN18
RPACK4-10K
RN19
RPACK4-1K
S2
DIP_SWITCH_4
USB_HOST_ON
USB_HOST1_ON
USB_DEVICE_ON
ETHERNET_ON
S A
0 B1
1 B2
Title
TMS570LC43x HDK
Size B
Document Number
FET SW 4 RMII & DIP SW
Rev B
Date: Tuesday, May 20, 2014
Sheet 18 of 29

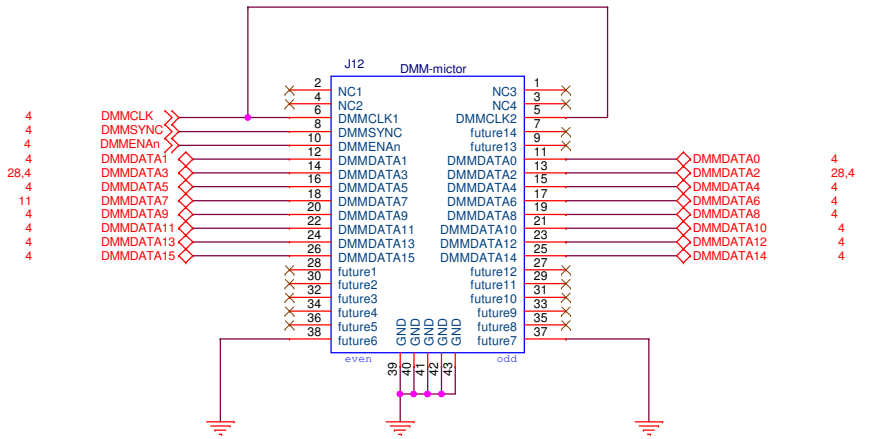

VCC_3V3
C101
0.1uF
R189
1.5K
R190
0
ETH_RESETn
24,25,28,7
VCC_3V3A
L2
Ferrite
C109
C110
0.1uF
0.1uF
R210
0
MDIO_D
MDIO_CLK
RMII_MHZ_50
LED_LINK
LED_ACT
R194
2.2K
R195
2.2K
D9
100Mb
PHY Addr [4:0]
=[RXD[0:3], COL]
RX_DV:
0=MII Mode;
1=RMII Mode
RX_ER=1, Disable
100Base_FX
U20
DP83640
R200
2.2K
R205
2.2K
R193
NOP
R377
R373
R374
R375
R376
MII_RX_CLK
MII_RX_DV
RMII_CRS_DV
RMII_RXER
MII_COL
MII_RXD3
MII_RXD2
RMII_RXD1
RMII_RXD0
GPIO9
RX_CLK
RX_DV
CRS/CRS_DV
RX_ER
COL
RXD_3
RXD_2
RXD_1
RXD_0
IO_VSS
IO_VDD
GPIO8
IO_CORE_VSS
X1
X2
IO_VDD
MDC
MDIO
RESET_N
LED_LINK
LED_SPEED
LED_ACT
GPIO4
CLK_OUT
GPIO3
GPIO2
GPIO1
VREF
ANA33VDD
ANAVSS
TD+
TD-
CD_VSS
RD+
RD-
TP8
R199
4.87K, 1%
VCC_3V3A
C107
10uF
C108
0.1uF
TX_CLK
TX_EN
TXD_0
TXD_1
TXD_2
TXD_3
PWRDOWN/INTN
TCK
TDO
TMS
TRST#
TDI
R378
22
MII_TX_CLK
RMII_TXEN
RMII_TXD0
RMII_TXD1
MII_TXD2
MII_TXD3
R207
10K
R209
2.2K
DIFFERENTIAL PAIR
xxx OHM DIFFERENTIAL
IMPEDANCE
SHORT AND STRAIGHT AS
POSSIBLE,
MINIMUM NUMBER OF VIAS
R201
49.9 1%
R202
49.9 1%
R204
49.9 1%
R203
49.9 1%
C102
NO-POP
C103
NO-POP
C104
NO-POP
C105
NO-POP
C176
0.01uF
C106
0.01uF
J1
J0011D21B
LNK
GRN
ACT
YEL
TD+
TXCT
TD-
RXD+
RXCT
RXD-
NC
CHS GND
SHLD1
SHLD2
75
75
1000pF
2kV
R197
2.2K
R196
360
R206
2.2K
R208
360
LED_LINK
LED_ACT
Strongly Recommend:
1. Add a 2.2K ohms pull-down resistors to RXD_2 and RXD_3 signals.
2. Add a 2.2K ohms pull-up resistor to CRS/CRS_DV signal
In MII mode (RX_DV=0): TXD3=1, No use
In RMII mode (RX_DV=1): TXD3=0, RMII slave, 50MHz input to X1
Title
TMS570LC43x HDK
Size B
Document Number
Ethernet PHY & Conn
Rev B
Date: Tuesday, May 20, 2014
Sheet 19 of 29





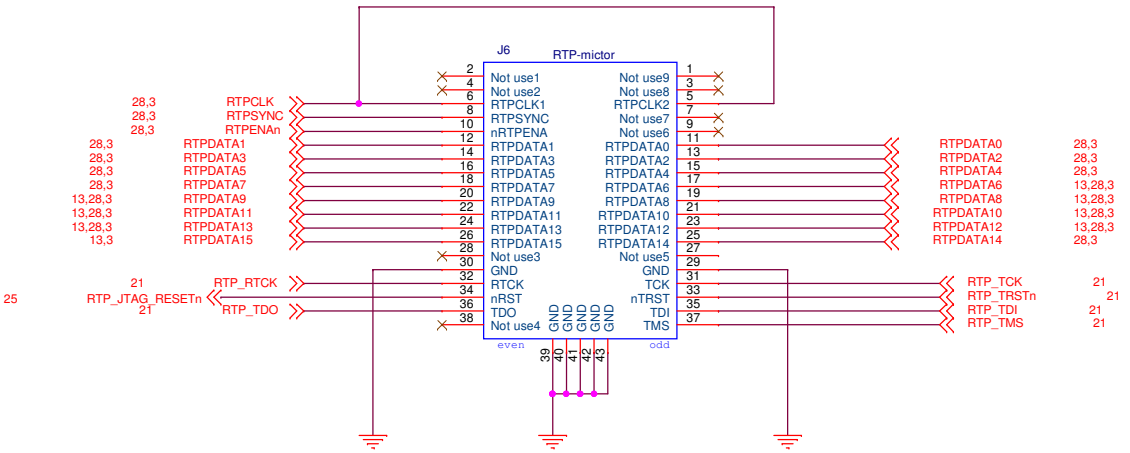
Title: TMS570LC43x HDK		
Size: B	Document Number: DCAN Transceivers	Rev: B
Date: Tuesday, May 20, 2014	Sheet 20 of 29	


VCC_3V3
R220
10k
JTAG_SELn
C117
NOP
R219
0
J4
ARM20PIN_JTAG
R221 22
R222 22
R223 22
R224 22
R227 22
XDS100_TDI 24,7
XDS100_TMS 24,7
XDS100_TCK 24,7
XDS100_RTCK 24,7
XDS100_TDO 24,7
2MCU_TRSTn 7
MCU_TDI 24,7
MCU_TMS 24,7
MCU_TCK 24,7
MCU_RTCK 24,7
MCU_TDO 24,7
MIPI_TDO R228 NOP
MIPI_RTCK R229 NOP
MIPI_TCK R230 NOP
MIPI_TMS R231 NOP
MIPI_TDI R232 NOP
MIPI_TRSTn R233 NOP
RTP_TDO 22
RTP_RTCK 22
RTP_TCK 22
RTP_TMS 22
RTP_TDI 22
RTP_TRSTn 22
ARM_JTAG_RESETn
ARM_JTAG_RESETn 25
R234
10k
25 MIPI_JTAG_RESETn
J19
ETM-MIPI
MIPI_TMS
MIPI_TDO
MIPI_TRSTn
TMS
TDO
nRSESET
nTRST
NC13
VCC2_3.3V
NC14
GND1
VCC1_3.3V
TCK
TDI
RTCLK
NC12
NC11
TRACECLKOUT
GND2
TRACECTL
TRACEDAT0
TRACEDAT1
TRACEDAT2
TRACEDAT3
TRACEDAT4
TRACEDAT5
TRACEDAT6
TRACEDAT7
TRACEDAT8
TRACEDAT9
TRACEDAT10
TRACEDAT11
TRACEDAT12
TRACEDAT13
TRACEDAT14
TRACEDAT15
TRACEDAT16
TRACEDAT17
TRACEDAT18
GND4
NC9
NC1
NC2
NC3
NC4
NC5
NC6
NC7
GND3
NC8
MH1
MH2
MH3
MH4
MIPI_TCK
MIPI_TDI
MIPI_RTCK
ETMTRACECLKOUT 5
ETMTRACECTL 5
ETMDATA0 5
ETMDATA1 5
ETMDATA2 5
ETMDATA3 5
ETMDATA4 5
ETMDATA5 5
ETMDATA6 5
ETMDATA7 5
ETMDATA8 13,28,3
ETMDATA9 13,28,3
ETMDATA10 13,28,3
ETMDATA11 13,28,3
ETMDATA12 13,28,5
ETMDATA13 28,5
ETMDATA14 13,28,5
ETMDATA15 13,28,5
ETMDATA16 13,28,5
ETMDATA17 13,28,5
ETMDATA18 13,28,5
13,28,5 ETMDATA19
13,28,5 ETMDATA20
13,28,5 ETMDATA21
13,28,5 ETMDATA22
13,28,5 ETMDATA23
13,28,5 ETMDATA24
13,28,5 ETMDATA25
13,28,5 ETMDATA26
13,28,5 ETMDATA27
13,28,5 ETMDATA28
13,28,5 ETMDATA29
13,28,5 ETMDATA30
13,28,5 ETMDATA31
MIPI
Connector
QSH-030-01
R235
0
U24
SN74AHC1G14
C118
0.1uF
T_DIS 24
220
R236
JTAG_DIS
DS1
JTAG_SELn
JTAG_SELn = HIGH --> XDS100
JTAG_SELn = LOW --> ARM
JTAG and MIPI
Title
TMS570LC43x HDK
Size B
Document Number
JTAG & MIPI Connectors
Rev B
Date: Tuesday, May 20, 2014
Sheet 21 of 29



Foot Print Only

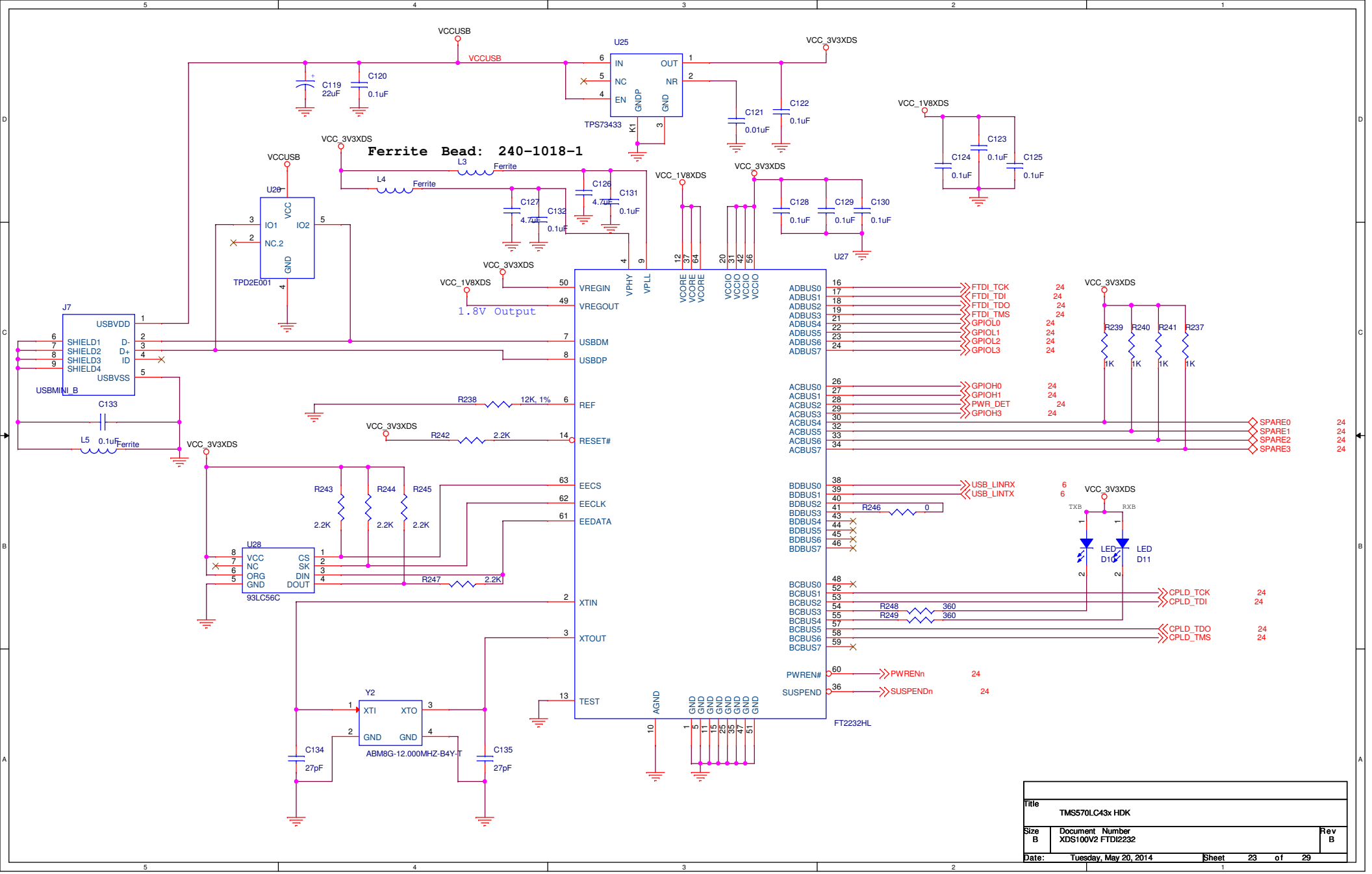
Pin39/40/41/42/43 are the central GND

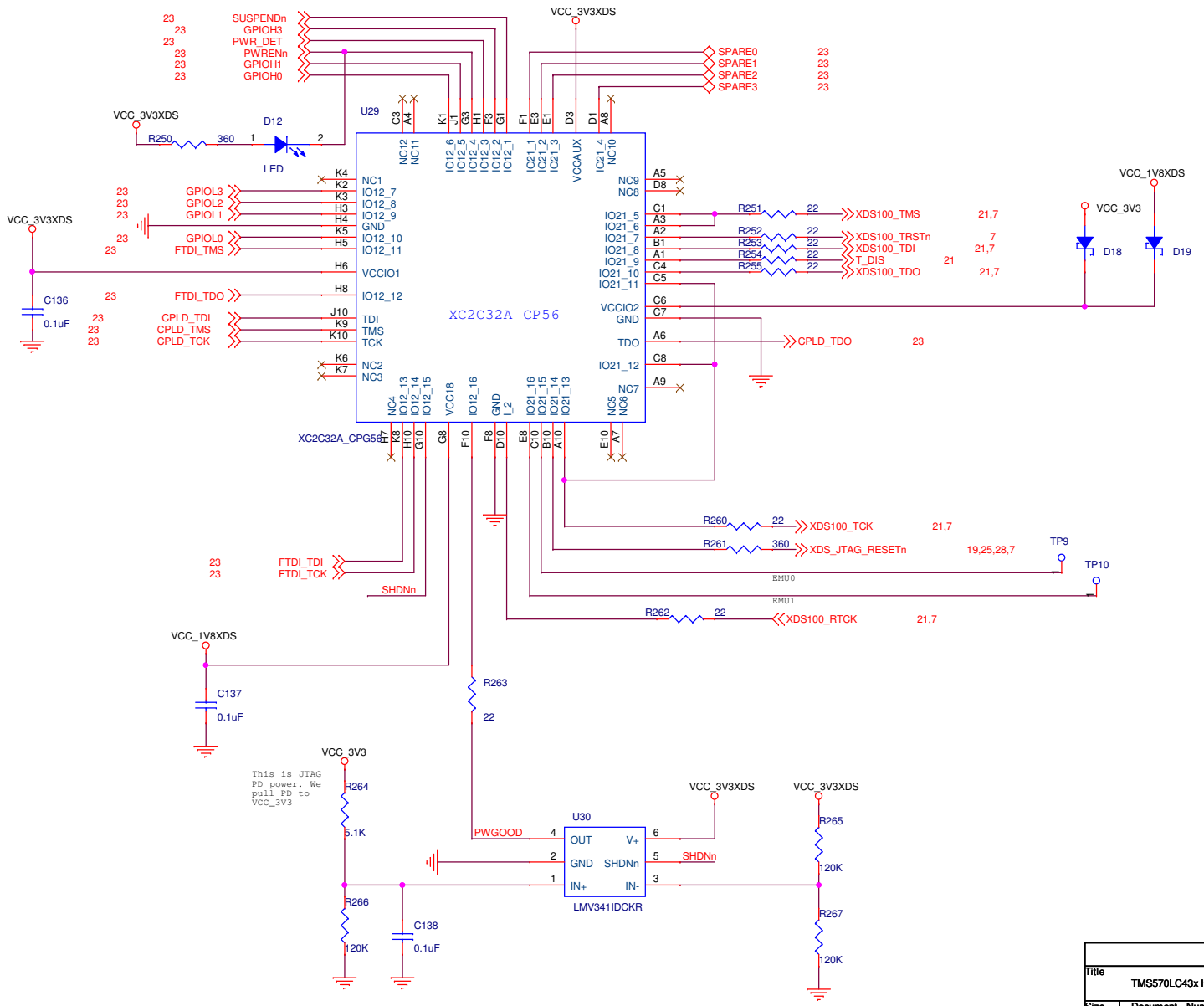


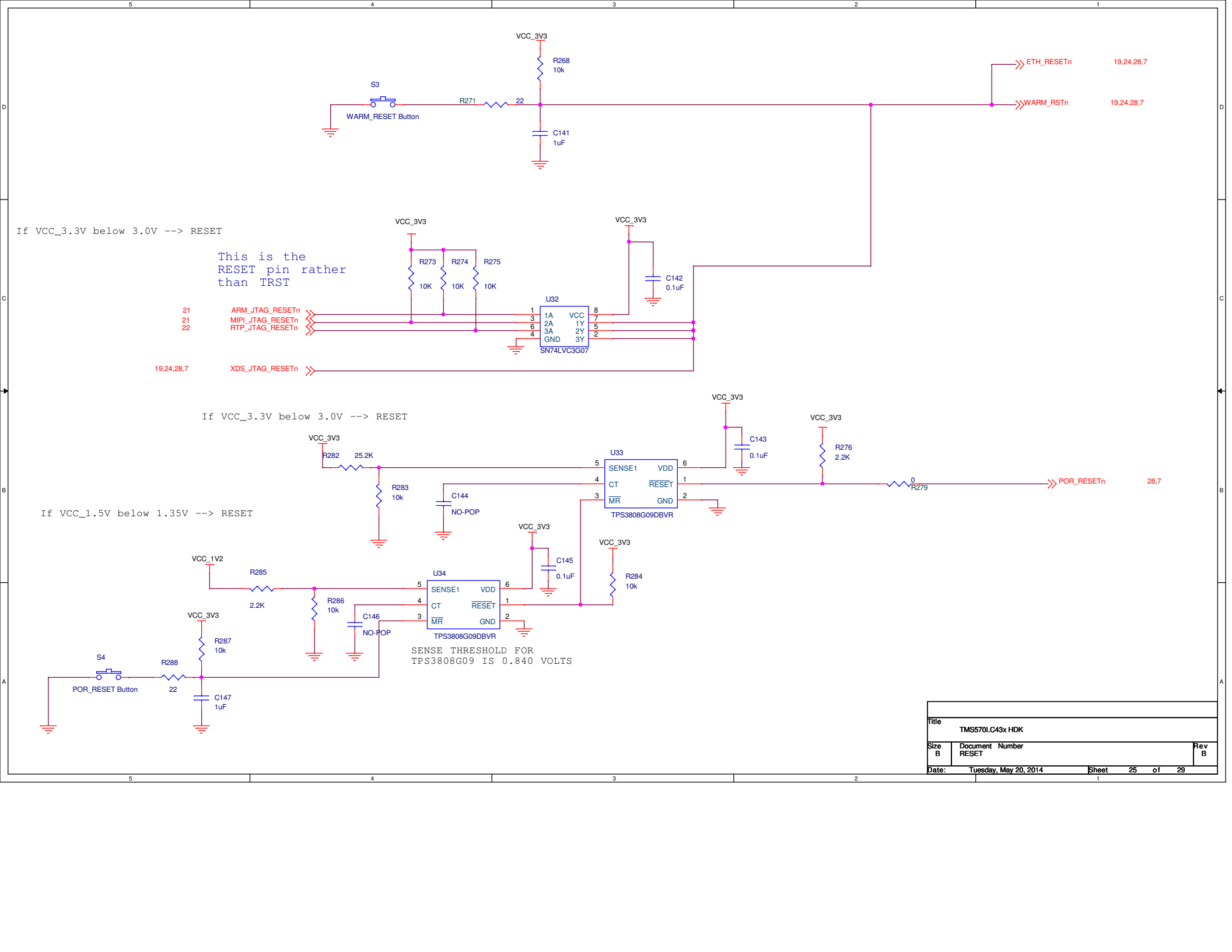
AMP 2-5767004-2
Receptacle, Center Strip Contacts

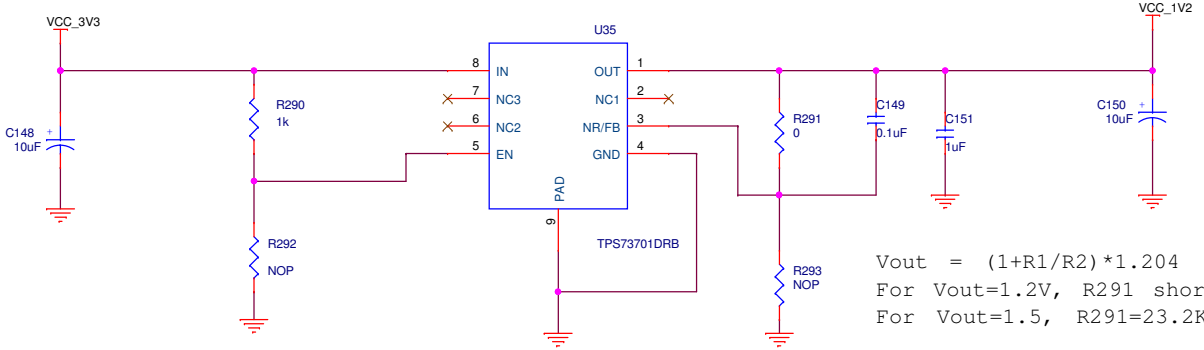
Foot Print Only

Title	TMS570LS3x/RM5x CPU CARD	
Size B	Document Number DMM and RTP Connectors	Rev B
Date: Tuesday, May 20, 2014	Sheet 22 of 29	


Ferrite Bead: 240-1018-1
1.8V Output
VCCUSB
VCC_3V3XDS
VCC_1V8XDS
U25
TPS73433
U20
TPD2E001
U27
J7
USBMINI_B
U28
93LC56C
Y2
ABM8G-12.000MHZ-B4Y-T
FT2232HL
C119 22uF
C120 0.1uF
C121 0.01uF
C122 0.1uF
C123
C124 0.1uF
C125 0.1uF
C126 4.7uF
C127 4.7uF
C128 0.1uF
C129 0.1uF
C130 0.1uF
C131 0.1uF
C132 0.1uF
C133
C134 27pF
C135 27pF
L3 Ferrite
L4 Ferrite
L5 0.1uF Ferrite
R238 12K, 1%
R239 1K
R240 1K
R241 1K
R242 2.2K
R243 2.2K
R244 2.2K
R245 2.2K
R246 0
R247 2.2K
R248 360
R249 360
VREGIN
VREGOUT
USBDM
USBDP
REF
RESET#
EECS
EECLK
EEDATA
XTIN
XTOUT
TEST
PWREN#
SUSPEND
ADBUS0 FTDI_TCK
ADBUS1 FTDI_TDI
ADBUS2 FTDI_TDO
ADBUS3 FTDI_TMS
ADBUS4 GPIOL0
ADBUS5 GPIOL1
ADBUS6 GPIOL2
ADBUS7 GPIOL3
ACBUS0 GPIOH0
ACBUS1 GPIOH1
ACBUS2 PWR_DET
ACBUS3 GPIOH3
SPARE0
SPARE1
SPARE2
SPARE3
BDBUS0 USB_LINRX
BDBUS1 USB_LINTX
BCBUS0 CPLD_TCK
BCBUS1 CPLD_TDI
BCBUS5 CPLD_TDO
BCBUS6 CPLD_TMS
PWRENn
SUSPENDn
LED D10
LED D11
TXB
RXB
Title
TMS570LC43x HDK
Size B
Document Number XDS100V2 FTDI2232
Rev B
Date: Tuesday, May 20, 2014
Sheet 23 of 29

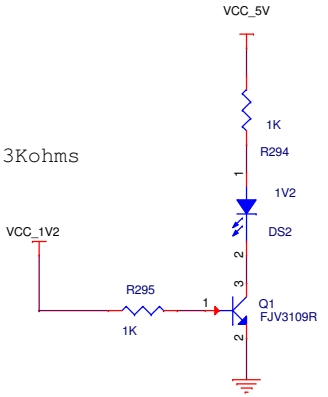

SUSPENDn
GPIOH3
PWR_DET
PWRENn
GPIOH1
GPIOH0
VCC_3V3XDS
SPARE0
SPARE1
SPARE2
SPARE3
U29
R250
360
D12
LED
GPIOL3
GPIOL2
GPIOL1
GPIOL0
FTDI_TMS
FTDI_TDO
CPLD_TDI
CPLD_TMS
CPLD_TCK
C136
0.1uF
XC2C32A CP56
XC2C32A_CPG56
R251
R252
R253
R254
R255
22
XDS100_TMS
XDS100_TRSTn
XDS100_TDI
T_DIS
XDS100_TDO
VCC_1V8XDS
VCC_3V3
D18
D19
CPLD_TDO
R260
R261
XDS100_TCK
XDS_JTAG_RESETn
TP9
TP10
EMU0
EMU1
R262
XDS100_RTCK
FTDI_TDI
FTDI_TCK
SHDNn
C137
R263
This is JTAG PD power. We pull PD to VCC_3V3
R264
5.1K
U30
OUT
V+
GND
SHDNn
IN+
IN-
LMV341IDCKR
PWGOOD
R265
120K
R266
R267
C138
Title
TMS570LC43x HDK
Size
B
Document Number
XDS100V2 CPLD
Rev
B
Date:
Tuesday, May 20, 2014
Sheet
24
of
29

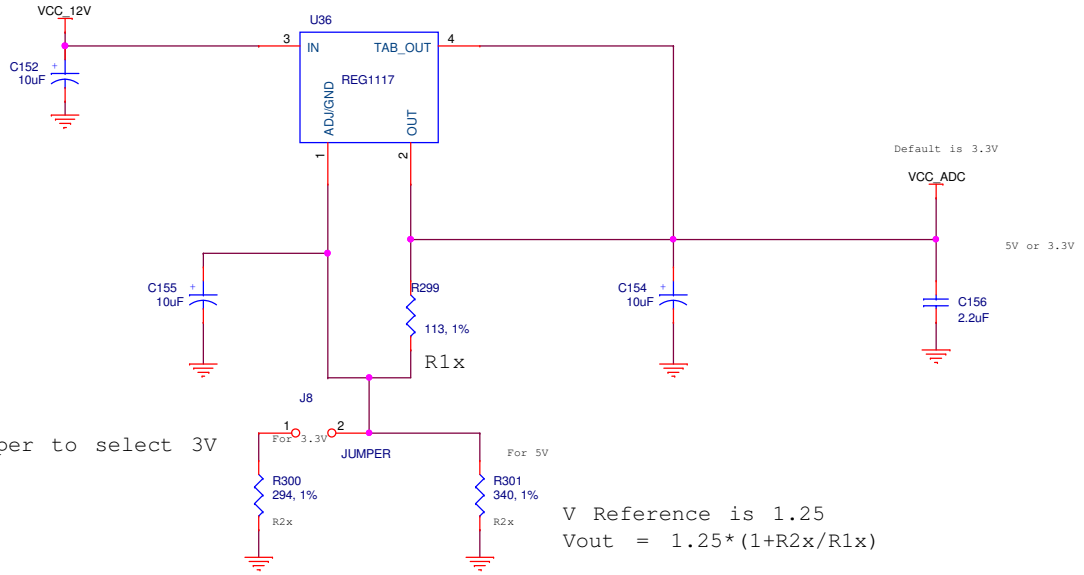

VCC_3V3
R268
10k
S3
WARM_RESET Button
R271
22
C141
1uF
ETH_RESETn
19,24,28,7
WARM_RSTn
19,24,28,7
If VCC_3.3V below 3.0V --> RESET
This is the RESET pin rather than TRST
VCC_3V3
R273
R274
R275
10K
10K
10K
VCC_3V3
C142
0.1uF
U32
21
ARM_JTAG_RESETn
21
MIPI_JTAG_RESETn
22
RTP_JTAG_RESETn
1A
2A
3A
GND
VCC
1Y
2Y
3Y
SN74LVC3G07
19,24,28,7
XDS_JTAG_RESETn
If VCC_3.3V below 3.0V --> RESET
VCC_3V3
R282
25.2K
R283
10k
C144
NO-POP
U33
SENSE1
CT
MR
VDD
RESET
GND
TPS3808G09DBVR
VCC_3V3
C143
0.1uF
VCC_3V3
R276
2.2K
0
R279
POR_RESETn
28,7
If VCC_1.5V below 1.35V --> RESET
VCC_1V2
R285
2.2K
R286
10k
C146
NO-POP
U34
SENSE1
CT
MR
VDD
RESET
GND
TPS3808G09DBVR
VCC_3V3
C145
0.1uF
VCC_3V3
R284
10k
VCC_3V3
R287
10k
S4
POR_RESET Button
R288
22
C147
1uF
SENSE THRESHOLD FOR
TPS3808G09 IS 0.840 VOLTS
Title
TMS570LC43x HDK
Size
B
Document Number
RESET
Rev
B
Date:
Tuesday, May 20, 2014
Sheet
25
of
29



Vout = (1+R1/R2)*1.204
For Vout=1.2V, R291 shorted, and R293 Open
For Vout=1.5, R291=23.2Kohms, and R293=95.3Kohms

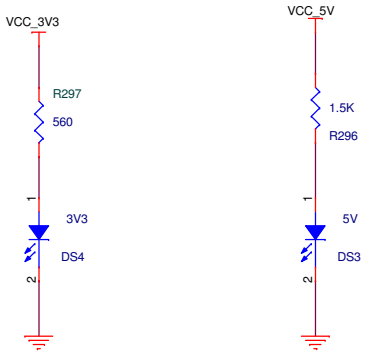
R281: ERJ-2RKF2322X



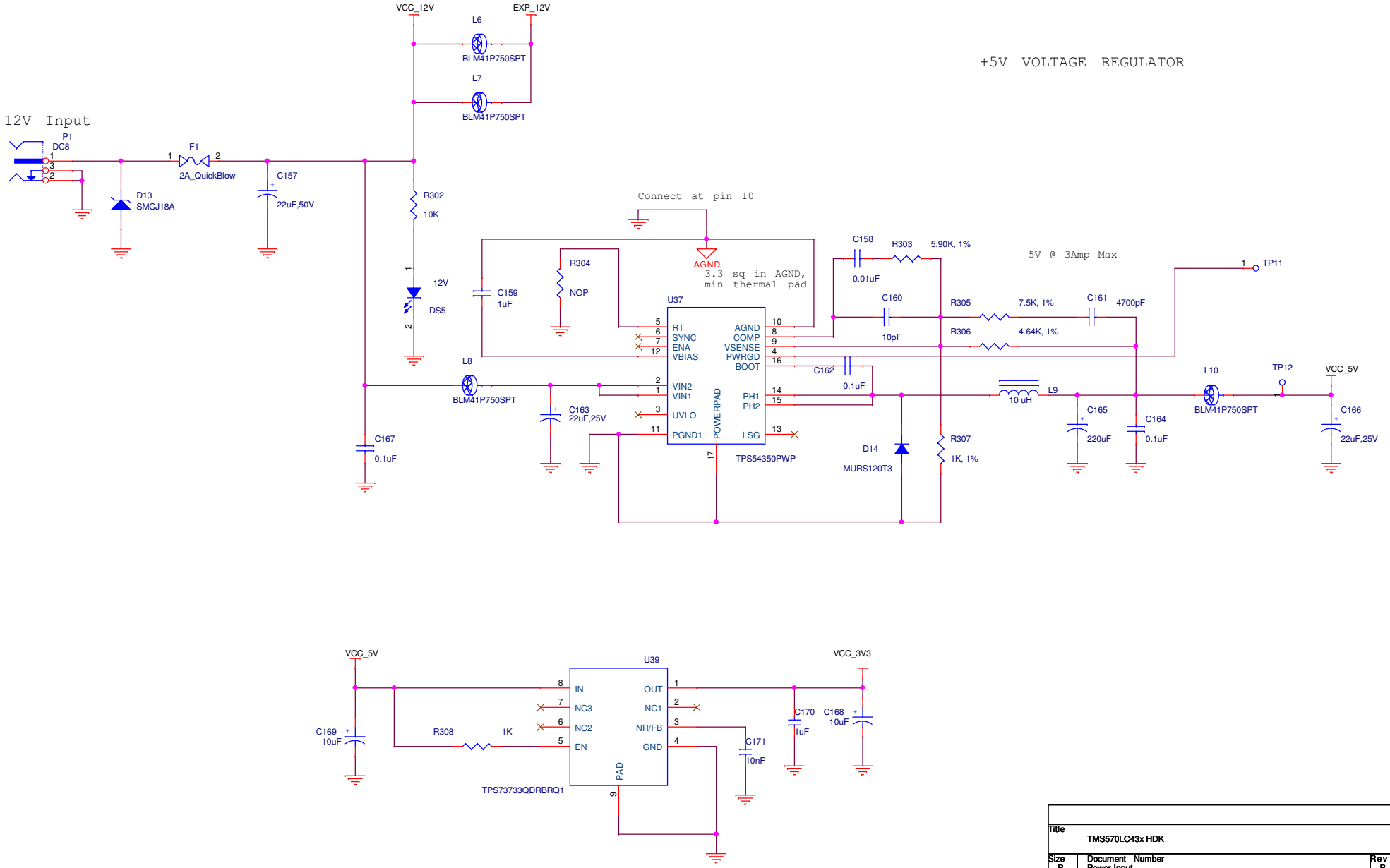


use jumper to select 3V

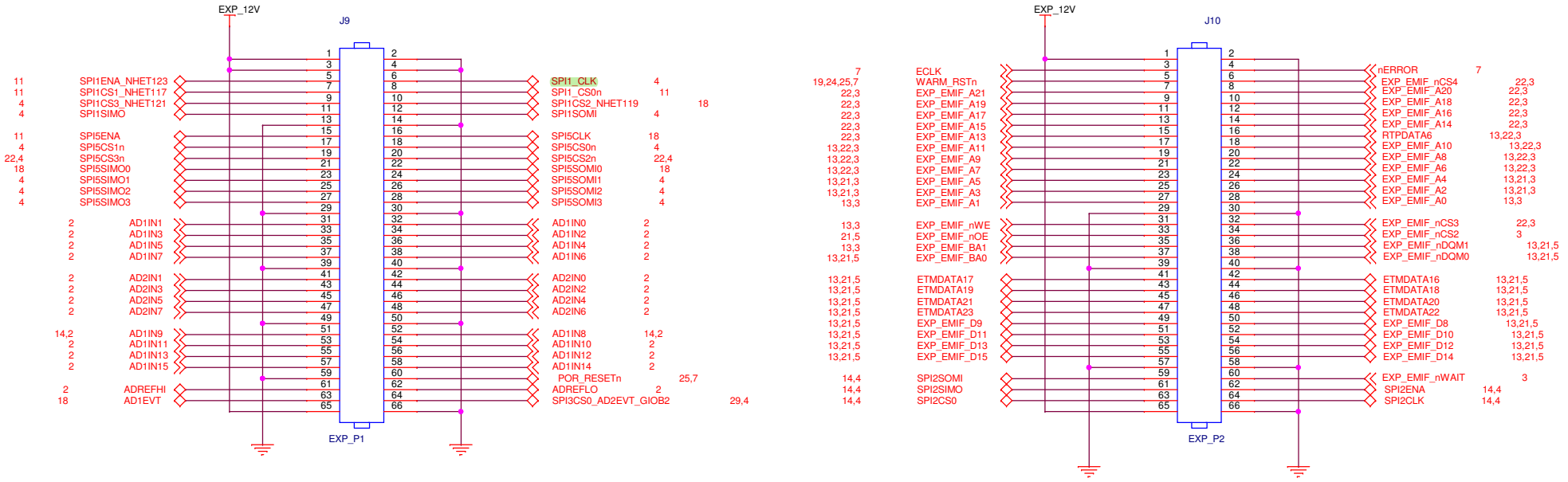
V Reference is 1.25
Vout = 1.25*(1+R2x/R1x)



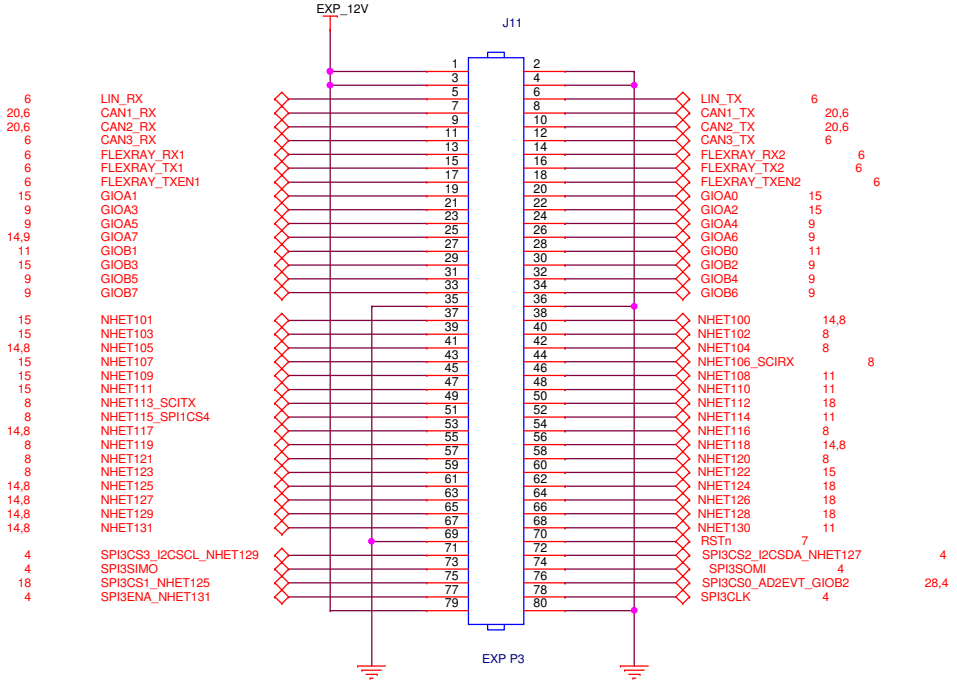
Title: TMS570LC43x HDK		
Size: B	Document Number: Power Supply	Rev: C
Date: Tuesday, May 20, 2014	Sheet 26 of 29	



Title	TMS570LC43x HDK	
Size B	Document Number Power Input	Rev B
Date: Tuesday, May 20, 2014	Sheet 27 of 29	



Title	TMS570LC43x HDK
Size B	Document Number: Expansion Connector 1
Rev	B
Date:	Tuesday, May 20, 2014
Sheet	28 of 29



Title	TMS570LC43x HDK	
Size B	Document Number Expansion Connector 2	Rev B
Date: Tuesday, May 20, 2014	Sheet 29 of 29	