- analysis shifter material on DocDB
- PCB stackup and material
- MOXA drivers

	VIRGINIA TECH(01)	
	P/N FEMALE_RA_MICROD	
	Wo# 140385	
	with coverlay	with no cover
Coverlay	0.002	
L1 .5Oz copper	0.0007	0.0007
.002 PANASONIC, IPC-4204/11	0.002	0.002
L2 .5Oz Copper	0.0007	0.0007
Coverlay	0.002	
Thickness Inch	**0.0074**	**0.0034**

Base material: PANASONIC, IPC-4204/11
Coverlay: Per IPC-4203/1

neutrinos in the Standard Model

- standard model leptons e, μ, τ each have associated neutrinos ν_e, ν_μ, ν_τ.
- Neutrinos only exist as left handed particles, so via the Higgs Mechanism and the Yuakawa interaction term, the Standard model predicts they are **massless**. $\mathcal{L}_{mass} = m_\ell \bar{\ell}_L \ell_R$

U(1) gauge invariance

$$\begin{pmatrix} \nu_\alpha \\ \ell_\alpha \end{pmatrix} \to e^{i\theta_\alpha} \begin{pmatrix} \nu_\alpha \\ \ell_\alpha \end{pmatrix}$$

$\implies$ **lepton flavor conservation**

$\implies \nu_\alpha \not\leftrightarrow \nu_\beta$

neutrino mixing

A given flavor eigenstate is a linear combination of mass eigenstates (PMNS-matrix)

$$|\nu_\alpha\rangle = \sum_{i=1}^{3} U_{\alpha i} |\nu_i\rangle$$

parameters: angles $\theta_{12}, \theta_{13}, \theta_{23}$ CP-violating phases $\delta_{CP}, \alpha_1, \alpha_2$, and neutrino masses m_1, m_2, m_3

$$U = \begin{pmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta_{CP}} \\ -s_{12}c_{23} - c_{12}s_{23}s_{13}e^{i\delta_{CP}} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta_{CP}} & s_{23}c_{13} \\ s_{12}s_{23} - c_{12}c_{23}s_{13}e^{i\delta_{CP}} & -c_{12}s_{23} - s_{12}c_{23}s_{13}e^{i\delta_{CP}} & c_{23 c_{13}} \end{pmatrix} \times \begin{pmatrix} e^{i\alpha_1/2} & 0 & 0 \\ 0 & e^{i\alpha_2/2} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

neutrino oscillations

- Homestake Mine and the solar neutrino anomaly
  $^{37}Cl + \nu_e \rightarrow \ ^{37}Ar + e^-$
  observes factor of 3 discrepancy in ν_e flux.

- Sudbury Neutrino Observatory (SNO) measures total neutrino flux: ν_μ, ν_τ account for ν_e deficit.

- KAMLAND, a reactor neutrino experiment shows survival probability of electron neutrinos (a function of the neutrino mass
  $P = 1 - sin^2(2\theta)sin^2(\Delta m^2 L\ 4E)$