

Tu2A-4

Improved temperature and power dependent Convolutional NN-based PA model

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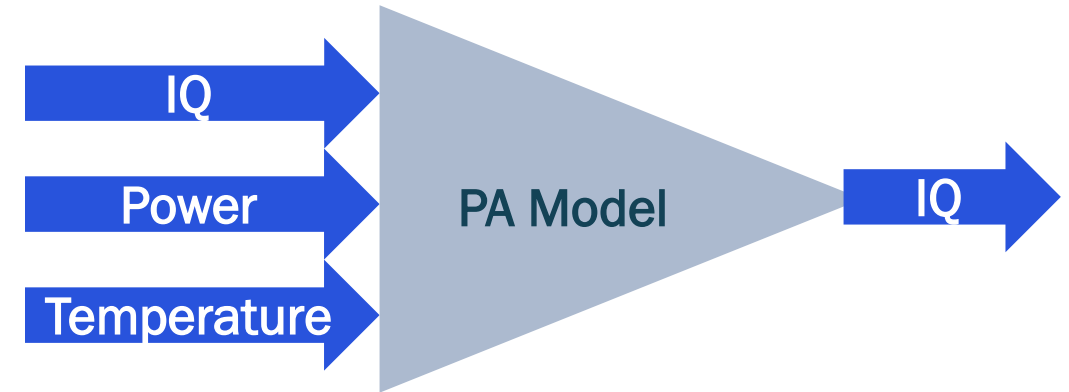
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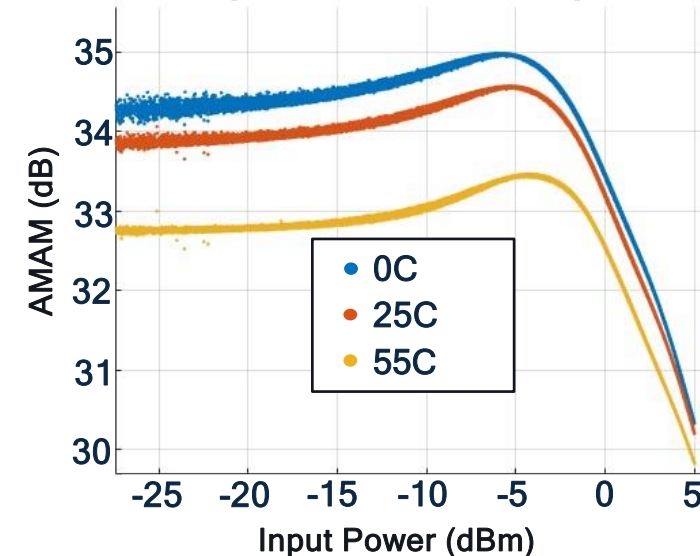
- Introduction
- Methodology for model evaluation
- Applied Innovations to the architecture
- Conclusion

Problem Statement

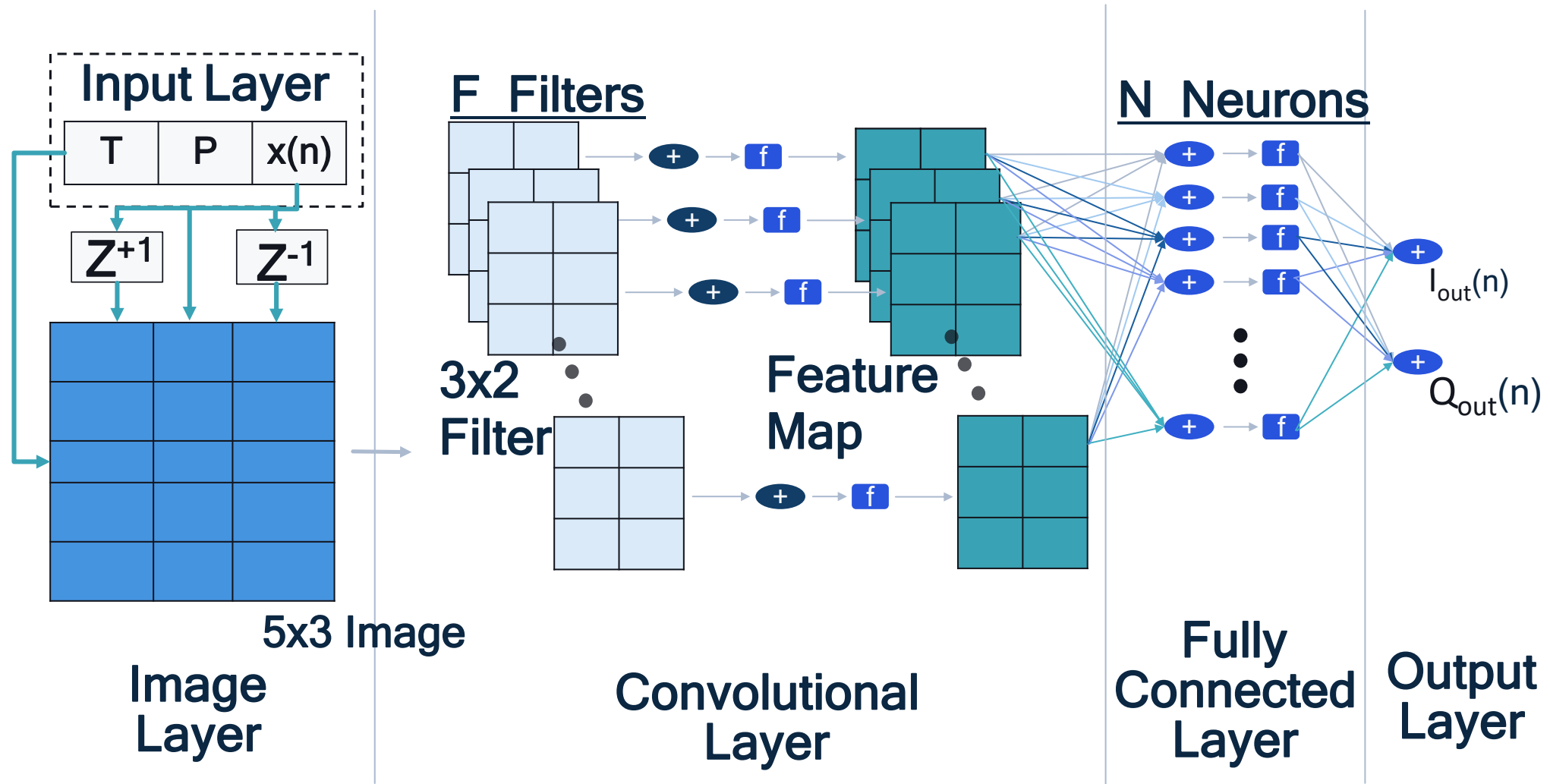
- Optimize state-of-the-art PA behavioral model networks
 - Pre-processing the input data
 - Changing the image layer format
- Improved performance while maintaining the same network complexity
- Parameterizable over several PA states



Model response with temperature:



Network Architecture



- Introduction
- Methodology for model evaluation
- Proposed new image and layer architecture and evaluation
- Conclusion

- **Fast Circuit Envelope level 3 (FCE3) models extracted on ADS**
 - 1 model per temperature
 - 16 temperatures \rightarrow (-45C up to 85C)
 - 4IPBOs – [0 2 4 6]dB
 - Waveforms generated
 - BW of 100MHz
 - BW of 15MHz
- **Training**
 - 3 temperatures [0 25 85] C
- **Tested**
 - -45C to 85C
 - The base line for evaluation was settled at:
 - 10 filters (size 3x2 each)
 - 50 neurons
 - The image layer size is set at 5x3

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Proposed New Image Layer

- Present sample, temperature and power placed in a central positions
 - Included in most convolution operations
 - Magnifying their presence on feature maps

$I(n)$	$I(n-1)$	$I(n-2)$
$Q(n)$	$Q(n-1)$	$Q(n-2)$
P	T	P
$ x(i) $	$ x(i-1) $	$ x(i-2) $
$ x(i) ^2$	$ x(i-1) ^2$	$ x(i-2) ^2$

$I(n+1)$	$I(n)$	$I(n-1)$
$Q(n+1)$	$Q(n)$	$Q(n-1)$
P	Y_T	Y_{TP}
$ x(i+1) $	$ x(i) $	$ x(i-1) $
$ x(i+1) ^2$	$ x(i) ^2$	$ x(i-1) ^2$

$I(n+1)$	$I(n)$
$Q(n+1)$	$Q(n)$
P	Y_T

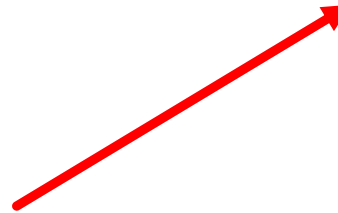
$I(n)$	$I(n-1)$
$Q(n)$	$Q(n-1)$
Y_T	Y_{TP}

$Q(n+1)$	$Q(n)$
P	Y_T
$ x(i+1) $	$ x(i) $

$Q(n)$	$Q(n-1)$
Y_T	Y_{TP}
$ x(i) $	$ x(i-1) $

P	Y_T
$ x(i+1) $	$ x(i) $
$ x(i+1) ^2$	$ x(i) ^2$

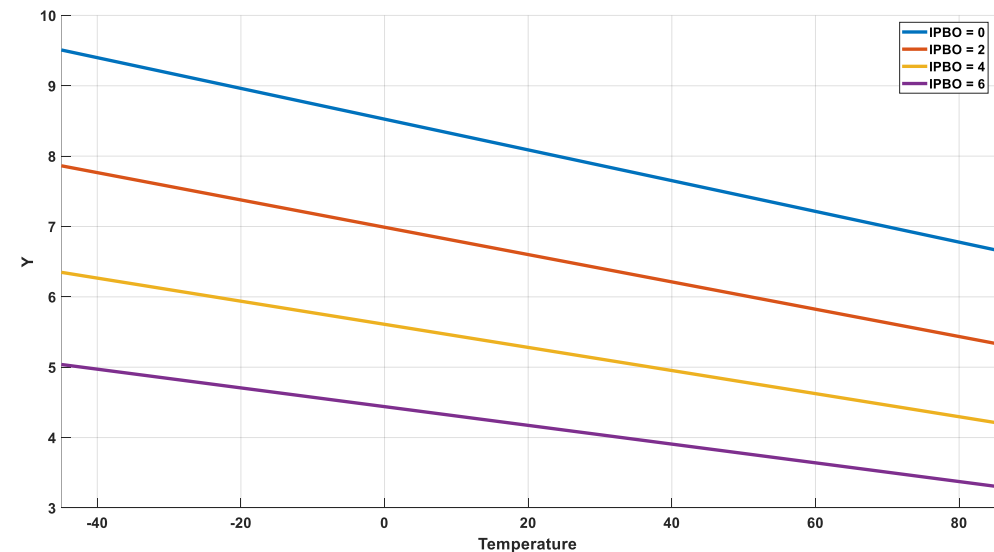
Y_T	Y_{TP}
$ x(i) $	$ x(i-1) $
$ x(i) ^2$	$ x(i-1) ^2$



Proposed New Image Layer

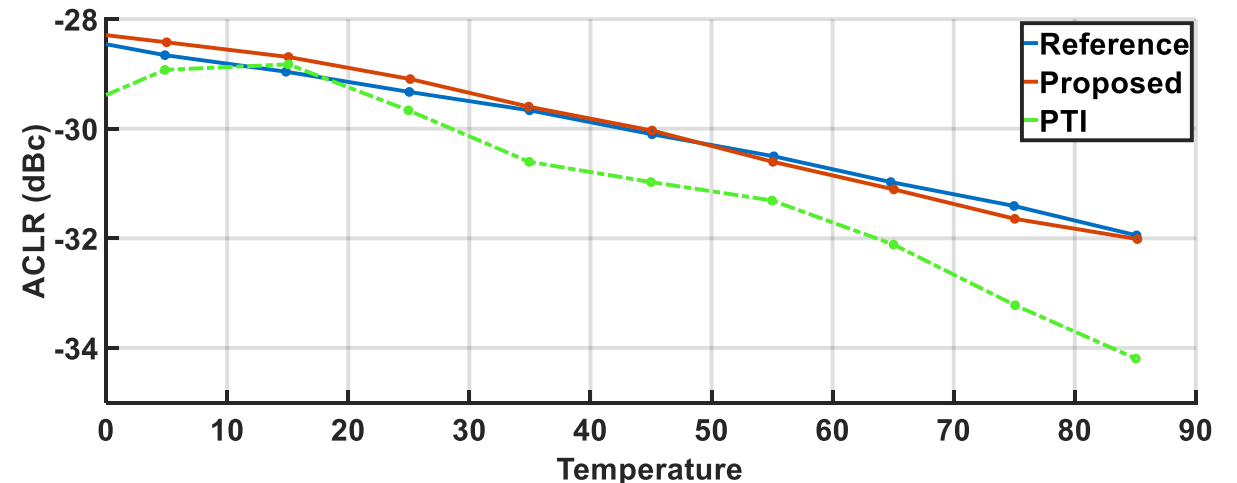
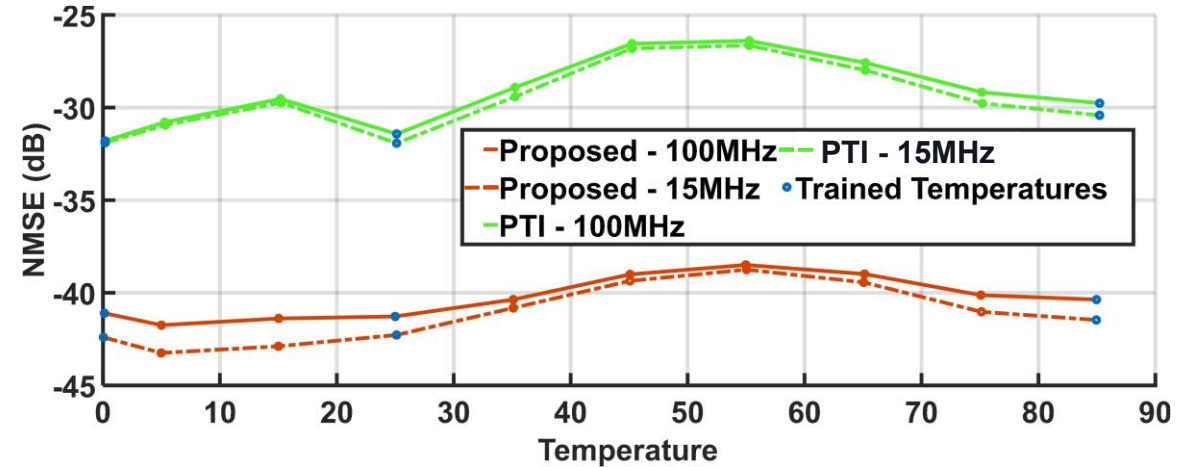
- The new architecture consists of:
 - Temperature input as function to the mean of the output waveform according to temperature and IPBO
 - $T \rightarrow Y$
 - $\text{Mean}(Y + \text{IPBO})^2$ used as input led to improved results

$I(n+1)$	$I(n)$	$I(n-1)$
$Q(n+1)$	$Q(n)$	$Q(n-1)$
P	Y_T	Y_{TP}
$ x(i+1) $	$ x(i) $	$ x(i-1) $
$ x(i+1) ^2$	$ x(i) ^2$	$ x(i-1) ^2$



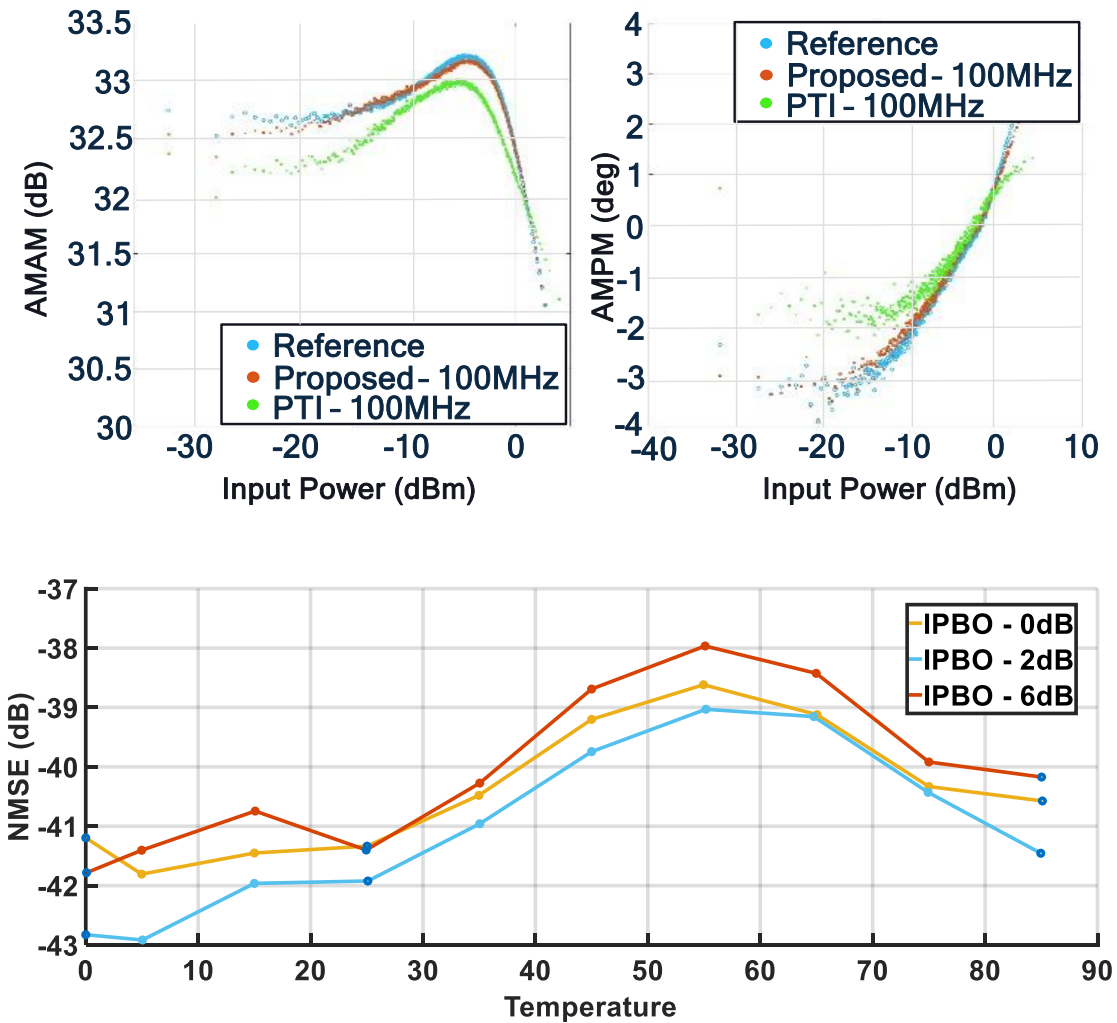
- Model performs accurately for both 100MHz and 15MHz BW.
- NMSE - PTI model
 - 100 MHz → -28.88dB
 - 15 MHz → -33.22dB
- NMSE - Proposed model
 - 100 MHz → -40.26dB
 - 15 MHz → -41.01dB

Results



- Proposed model follows reference AMAM/AMPM values much closer than previous model.
- NMSE is constant across different IPBOs.
 - IPBO - 0dB -> -40.26 dB
 - IPBO - 2dB -> -41.03 dB
 - IPBO - 6dB -> -40.06 dB

Results



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- Pre-processing is used to enhance the PA state characteristics.
- Important parameters of the data are promoted in feature maps.
- Model tested and validated from -45 to 85 °C and 0 to 6 dB.
- Improved model performance with same network complexity.

Thank you