Impact of longer wavelengths fiber response in the 25 Gb/s link budget

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Introduction and objectives

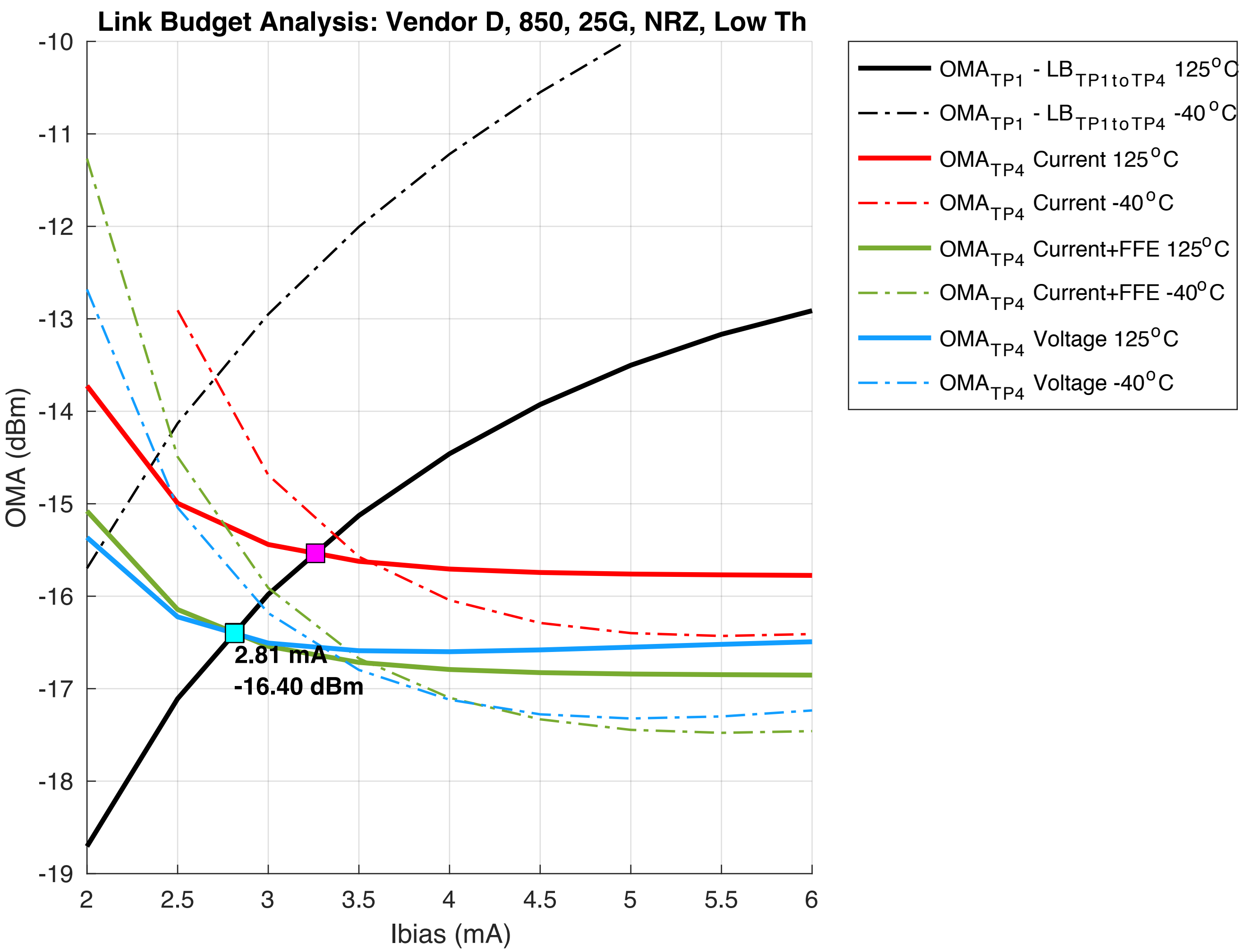
- Use of longer wavelengths VCSELs might be beneficial to improve the wear-out reliability
- In this contribution it is analyzed how the reduced EMB (Effective Modal Bandwidth) of the fiber caused by the operation in longer wavelength affects the receiver sensitivity
- In the analysis, the only one parameter that is changed is the fiber BW_{eff} (effective bandwidth length product) based on the EMB and the BW_{CD} (Bandwidth due to Chromatic Dispersion)
- VCSEL devices, photodiodes and TIA are the same, making possible to examine the single effect of BW_{eff}
- The link budget analysis is based on the link model presented in perezaranda_OMEGA_01_131020_link_model.pdf and the assumptions of perezaranda_OMEGA_02_131020_25G_link_budget.pdf

Effective fiber bandwidth length product

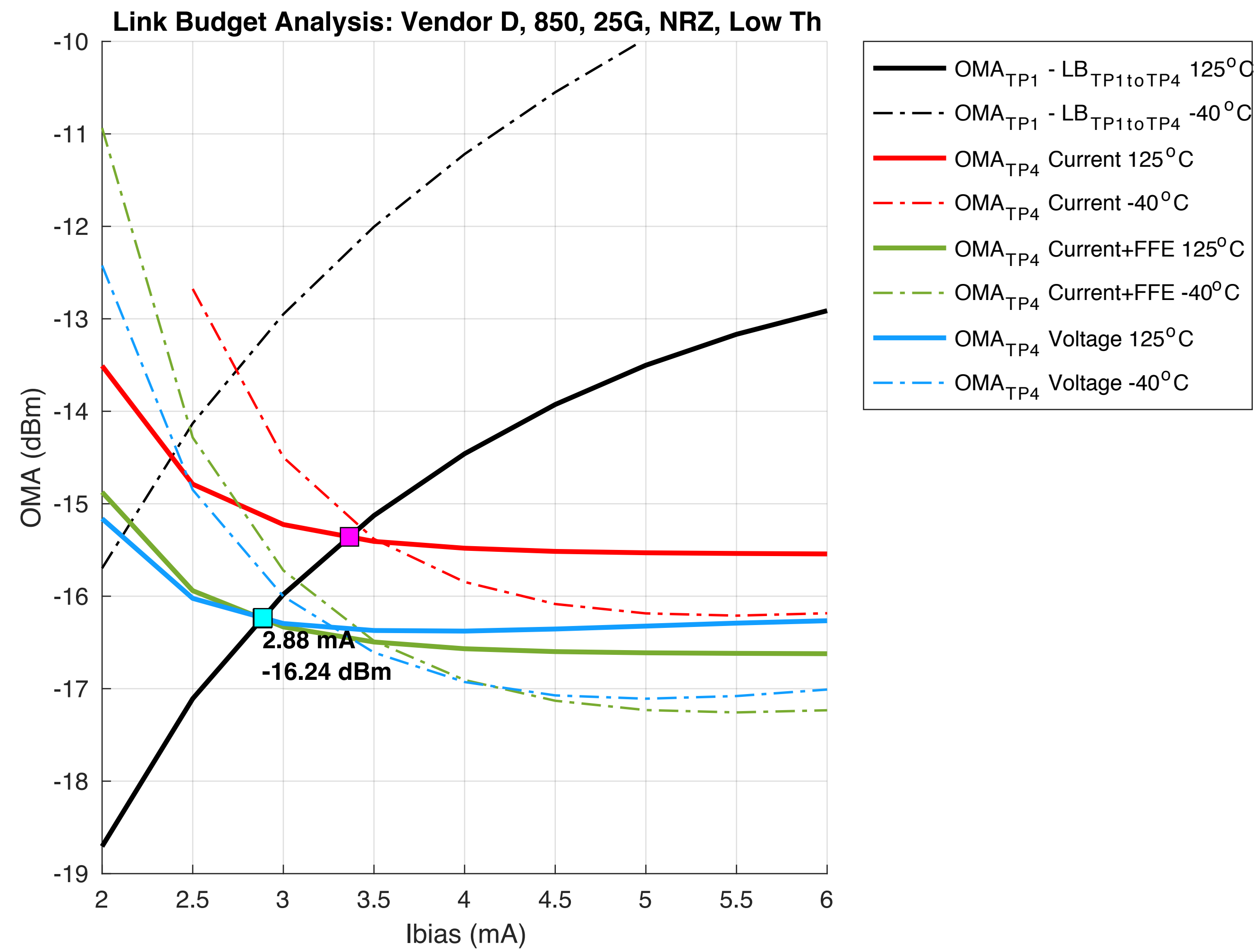
- Center wavelength of 980nm is considered
- From IEC 60793-2-10:2019, annex E.2, it can be extrapolated the EMB
  - We used equation (E4) defined for center lambdas between 850nm and 953nm
  - Using 3rd order polynomial MSE fitting of 1/EMB vs. center lambda we got extrapolation of EMB = 950 MHz·km at 980nm
- Chromatic dispersion bandwidth is calculated as BW_{CD} = 5498 MHz·km
- Therefore, BW_{eff} = 936 MHz·km at 980 nm
- For comparison, BW_{eff} = 1665 MHz·km at 850 nm (+78%)

Vendor D, 850 nm, 25G, NRZ, low th — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



BW_{eff} = 936 MHz·km



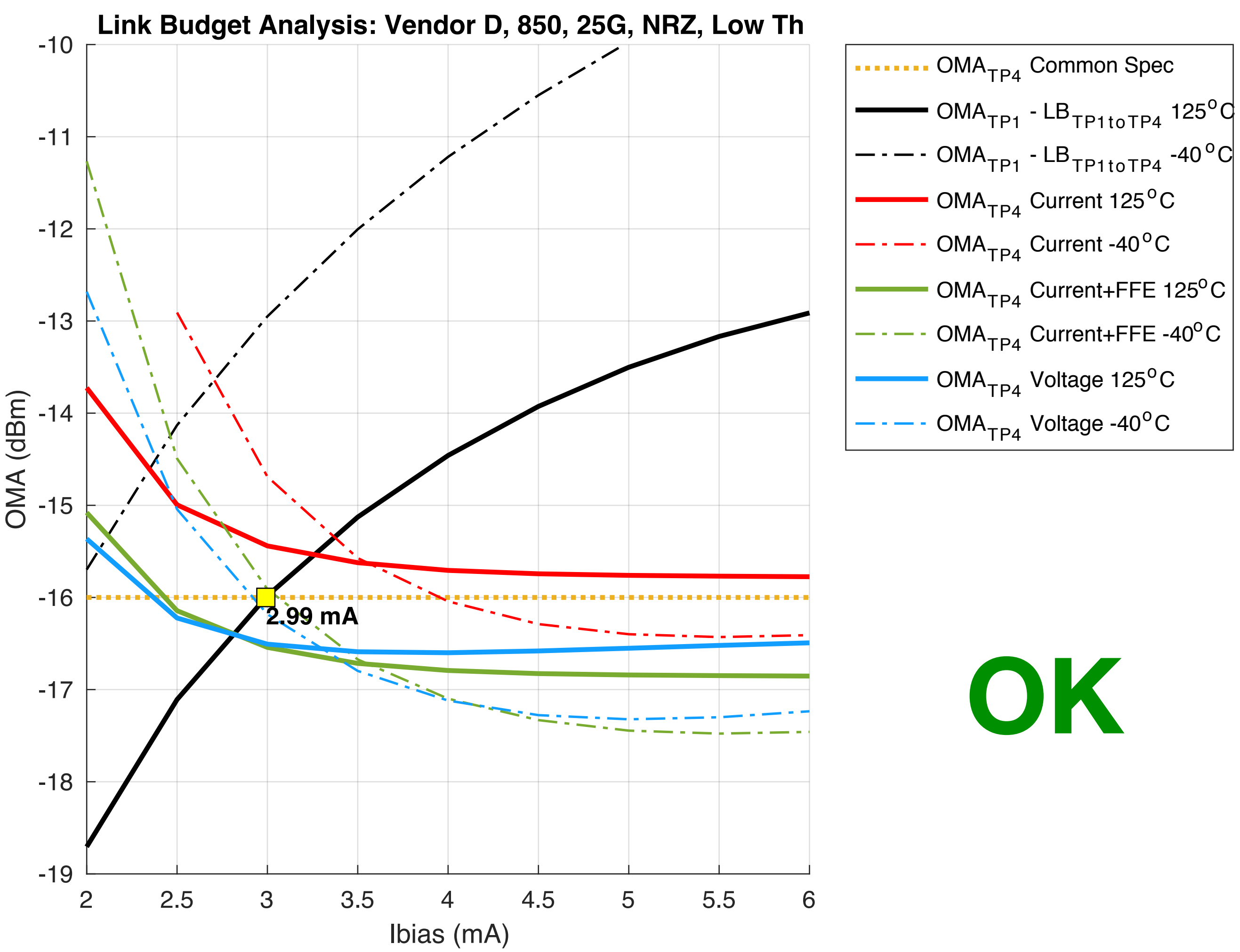
ΔOMA_{TP4} = 0.16 dB

$\Delta I_{BIAS,min}$ = 0.07 mA

@ 125ºC

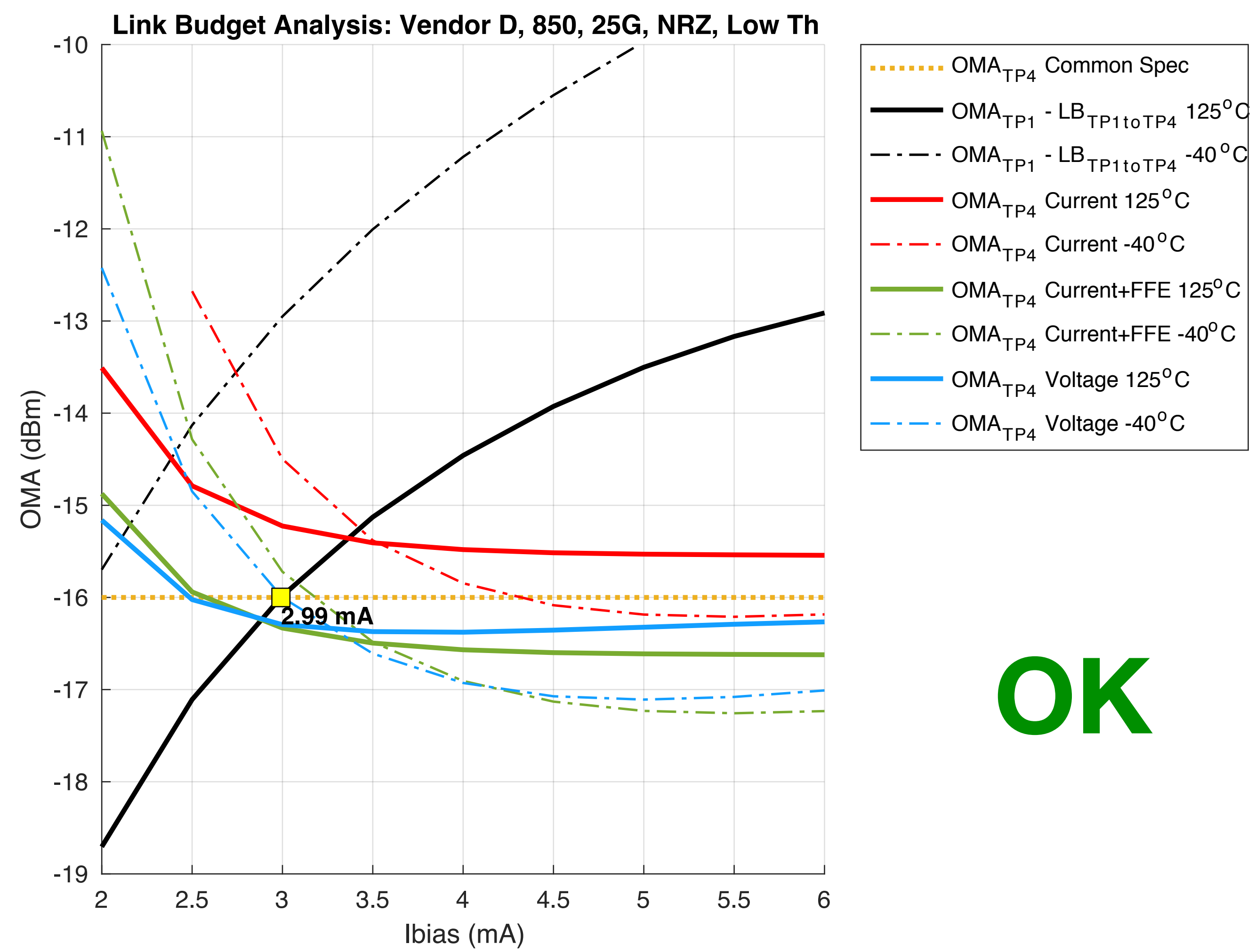
Vendor D, 850 nm, 25G, NRZ, low th — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



OK

BW_{eff} = 936 MHz·km

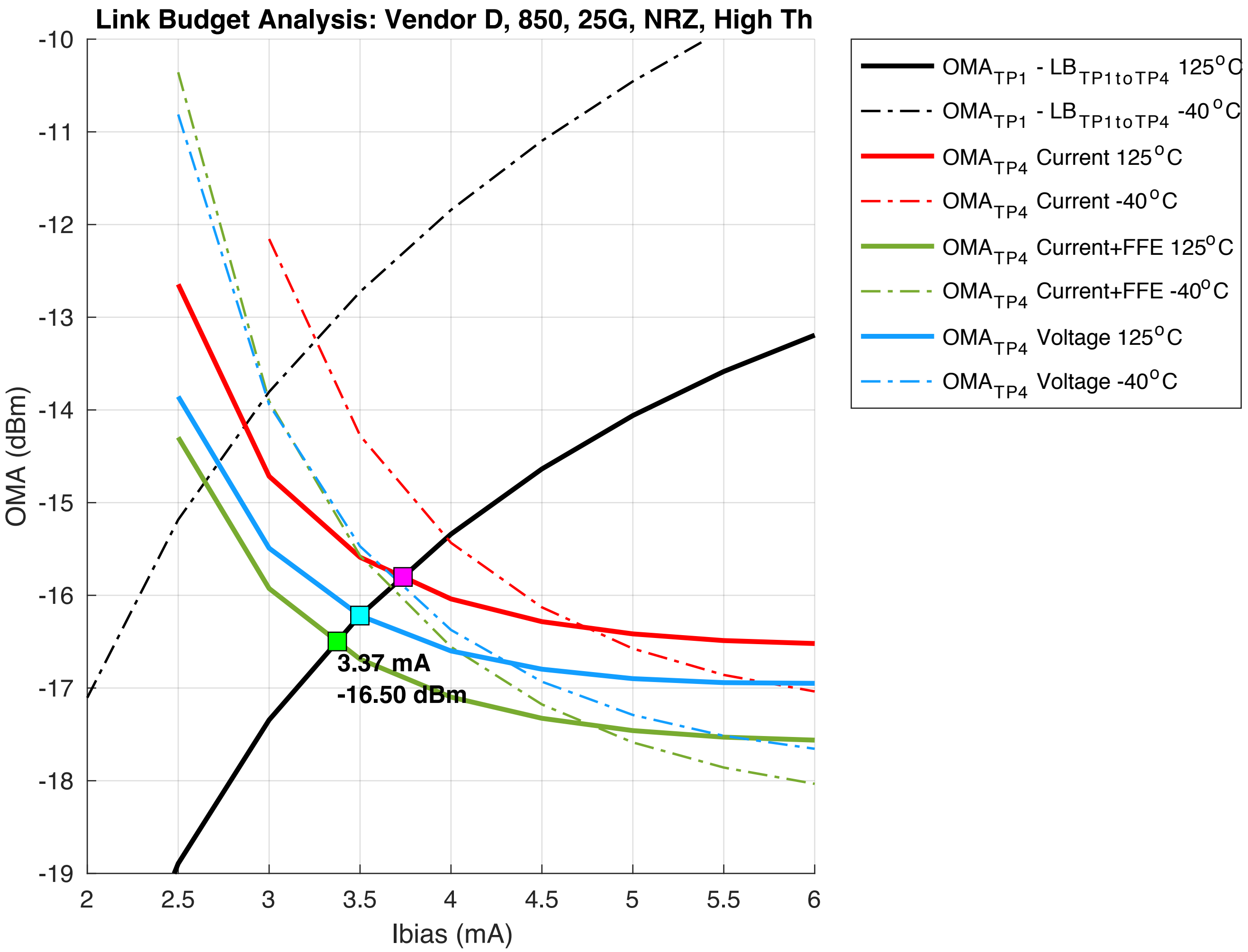


OK

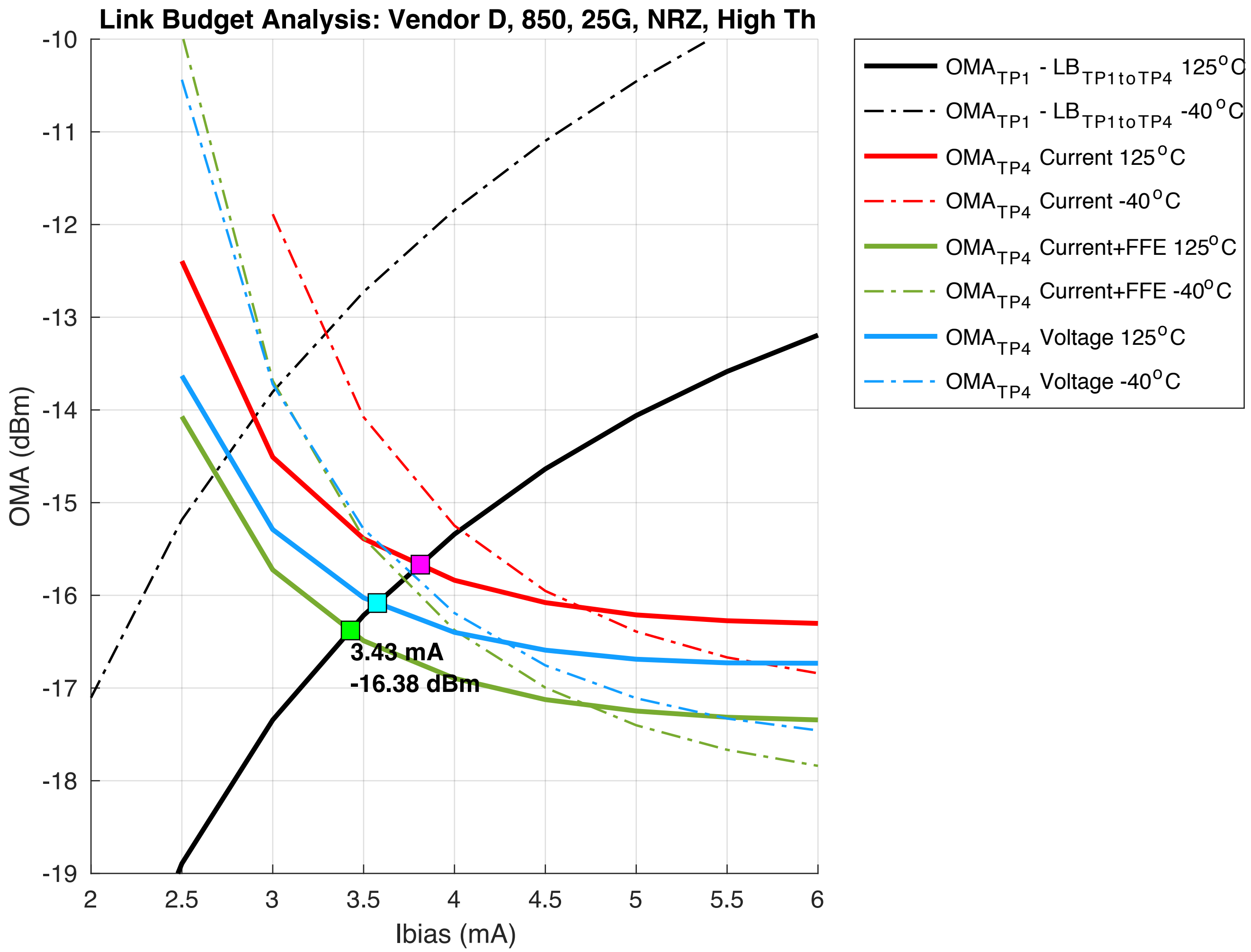
$\Delta I_{BIAS,min}$ = 0.00 mA
@ 125ºC

Vendor D, 850 nm, 25G, NRZ, high th — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



BW_{eff} = 936 MHz·km



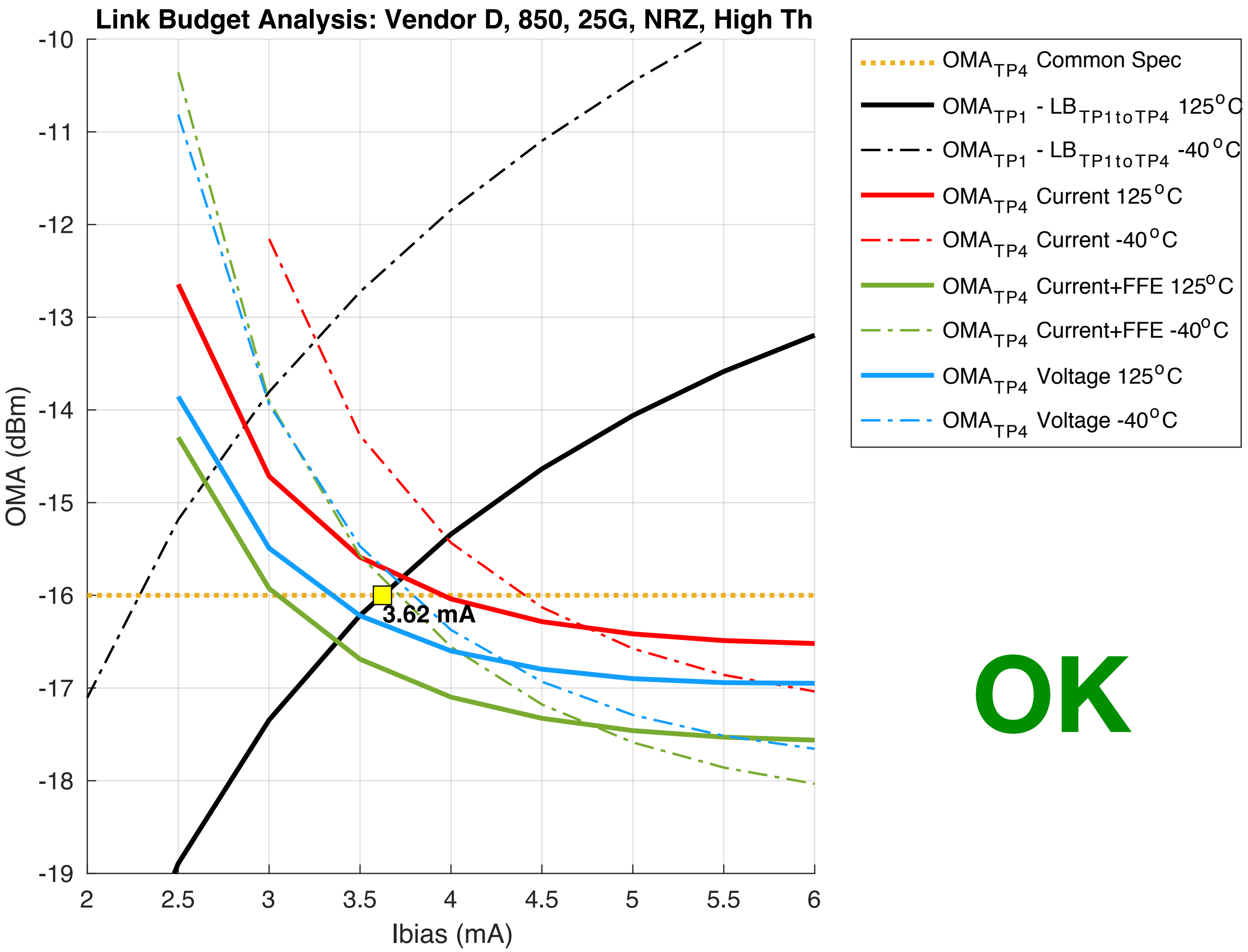
ΔOMA_{TP4} = 0.12 dB

$\Delta I_{BIAS,min}$ = 0.05 mA

@ 125ºC

Vendor D, 850 nm, 25G, NRZ, high th — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



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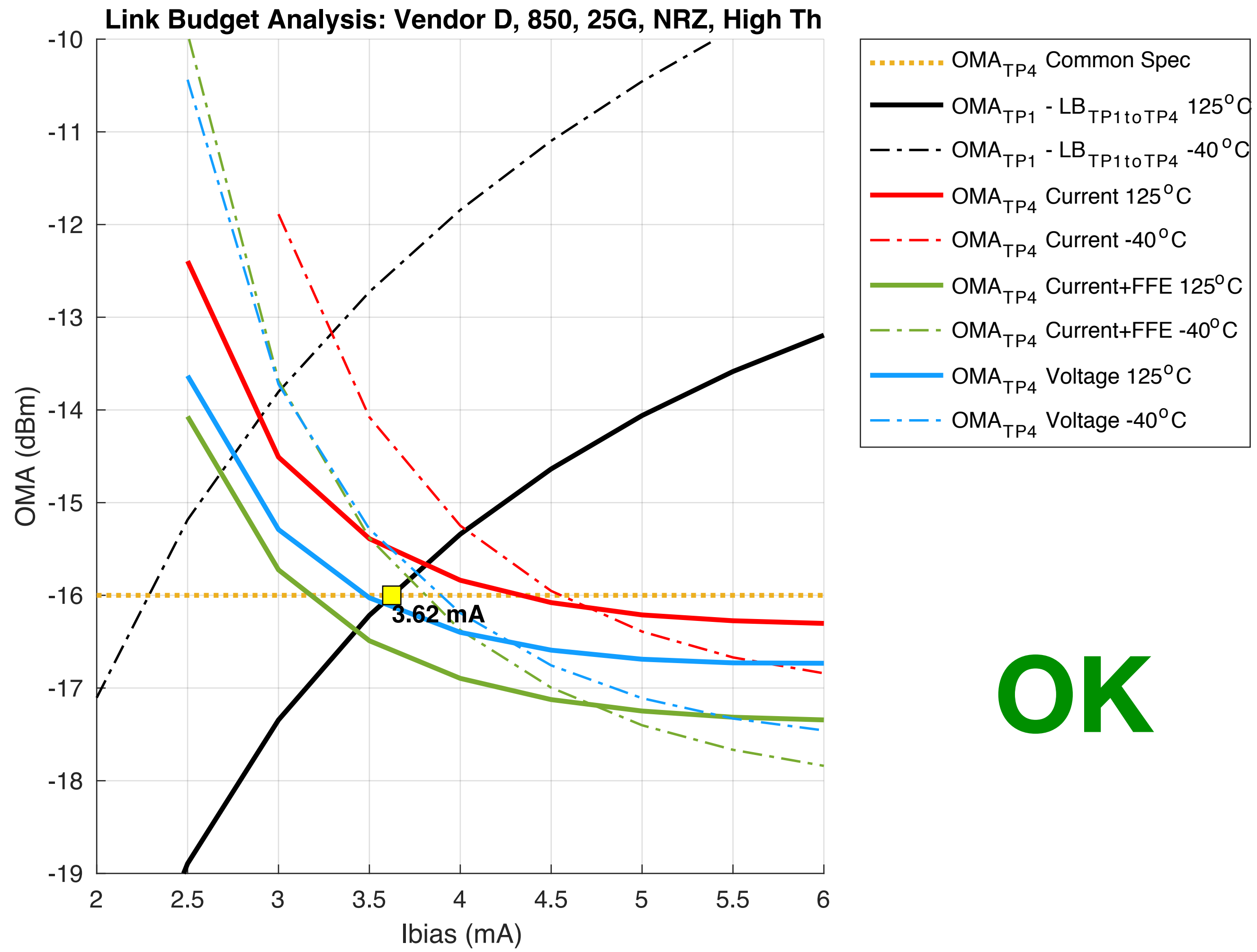
BW_{eff} = 936 MHz·km

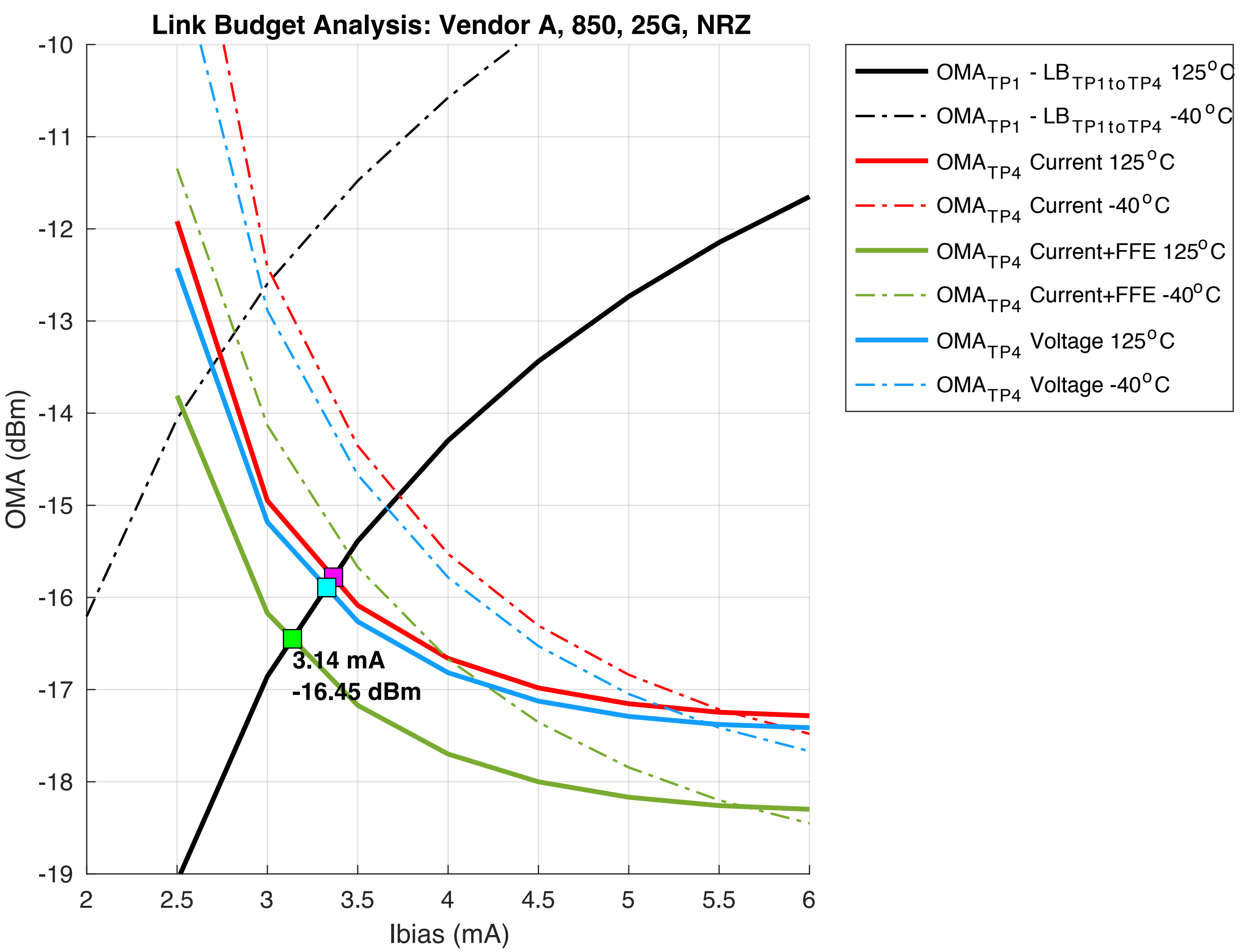


OK

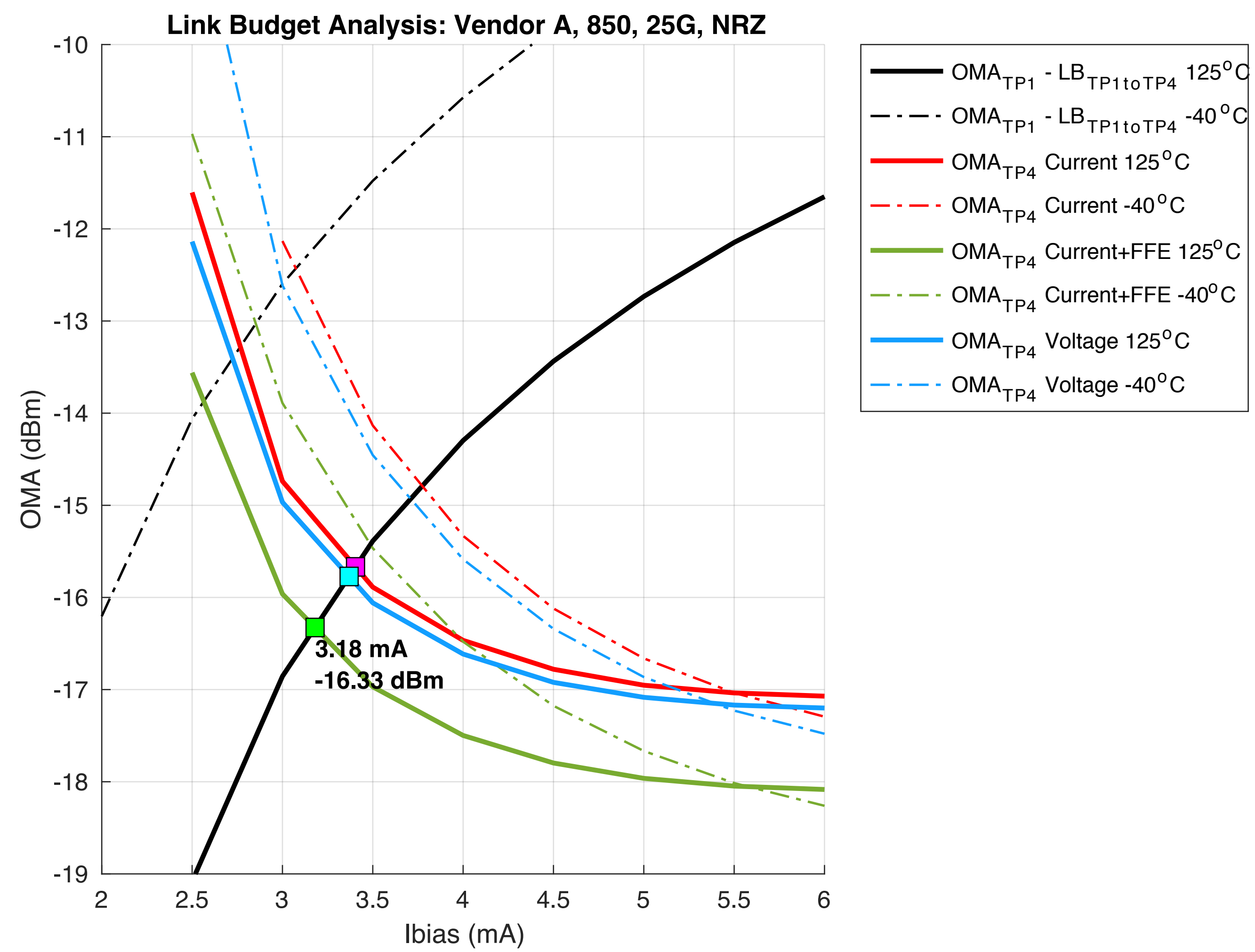
$\Delta I_{BIAS,min}$ = 0.00 mA @ 125°C

Vendor A, 850 nm, 25G, NRZ — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



BW_{eff} = 936 MHz·km



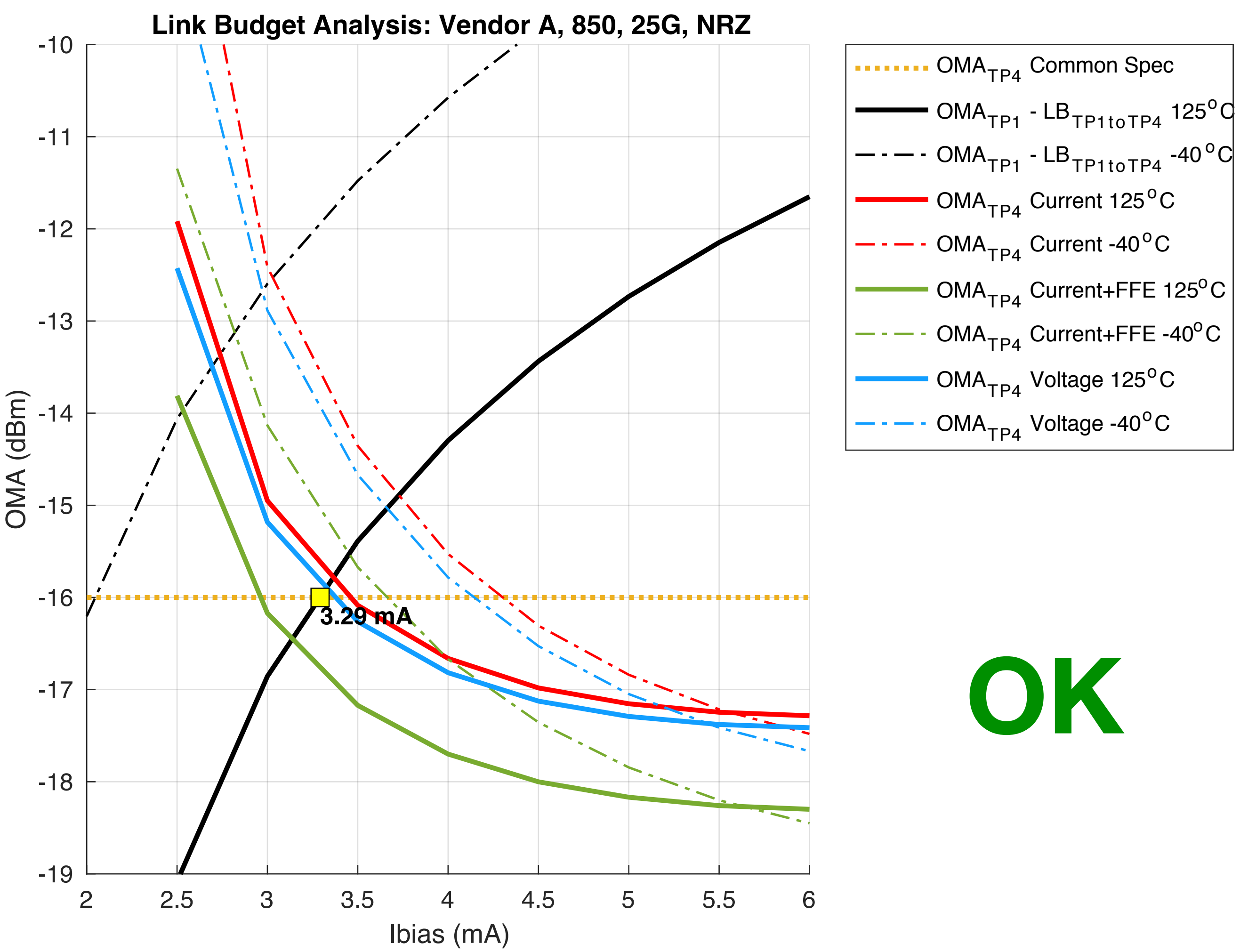
ΔOMA_{TP4} = 0.12 dB

$\Delta I_{BIAS,min}$ = 0.04 mA

@ 125ºC

Vendor A, 850 nm, 25G, NRZ — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



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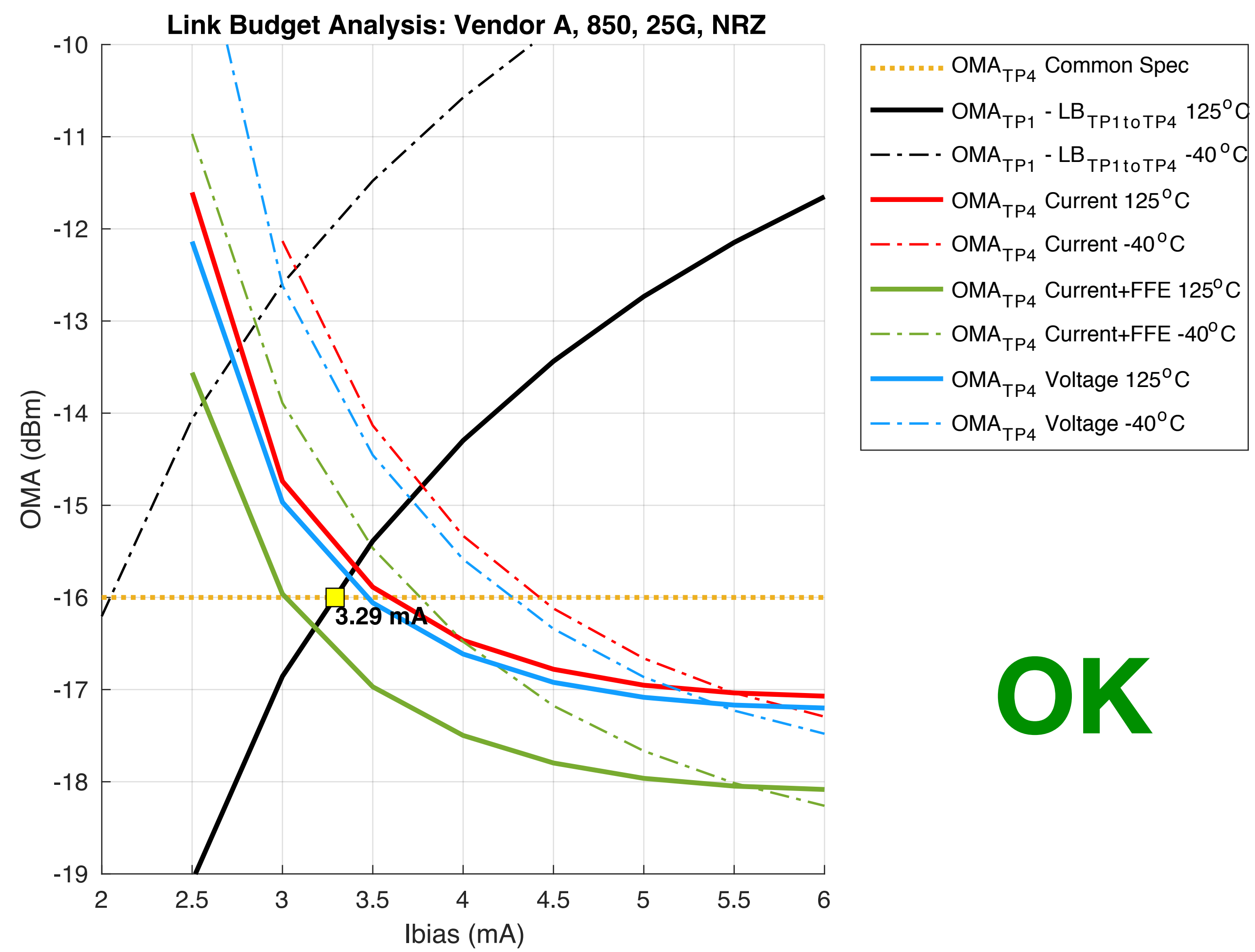
BW_{eff} = 936 MHz·km

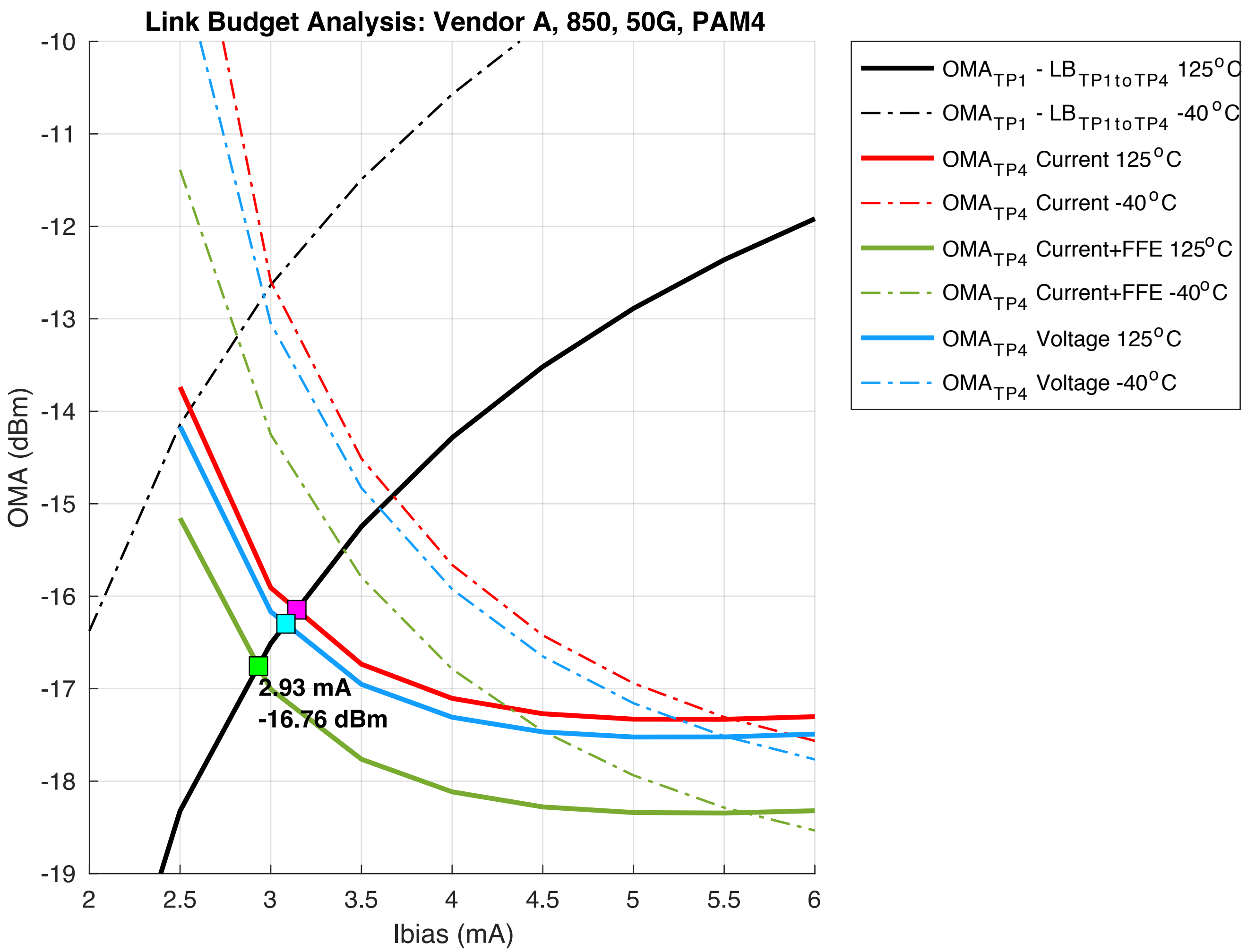


OK

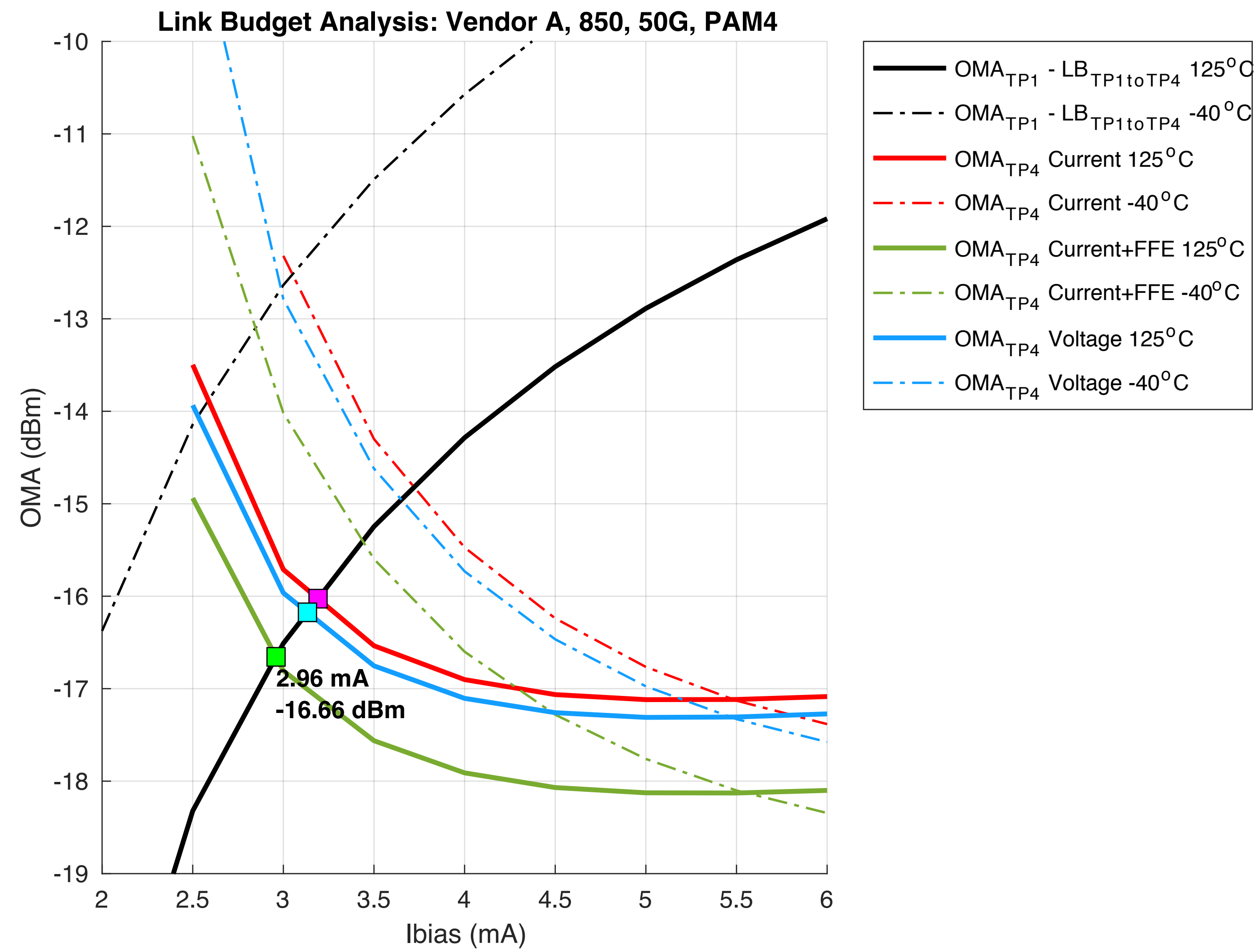
$\Delta I_{BIAS,min}$ = 0.00 mA @ 125°C

Vendor A, 850 nm, 50G, PAM4 — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



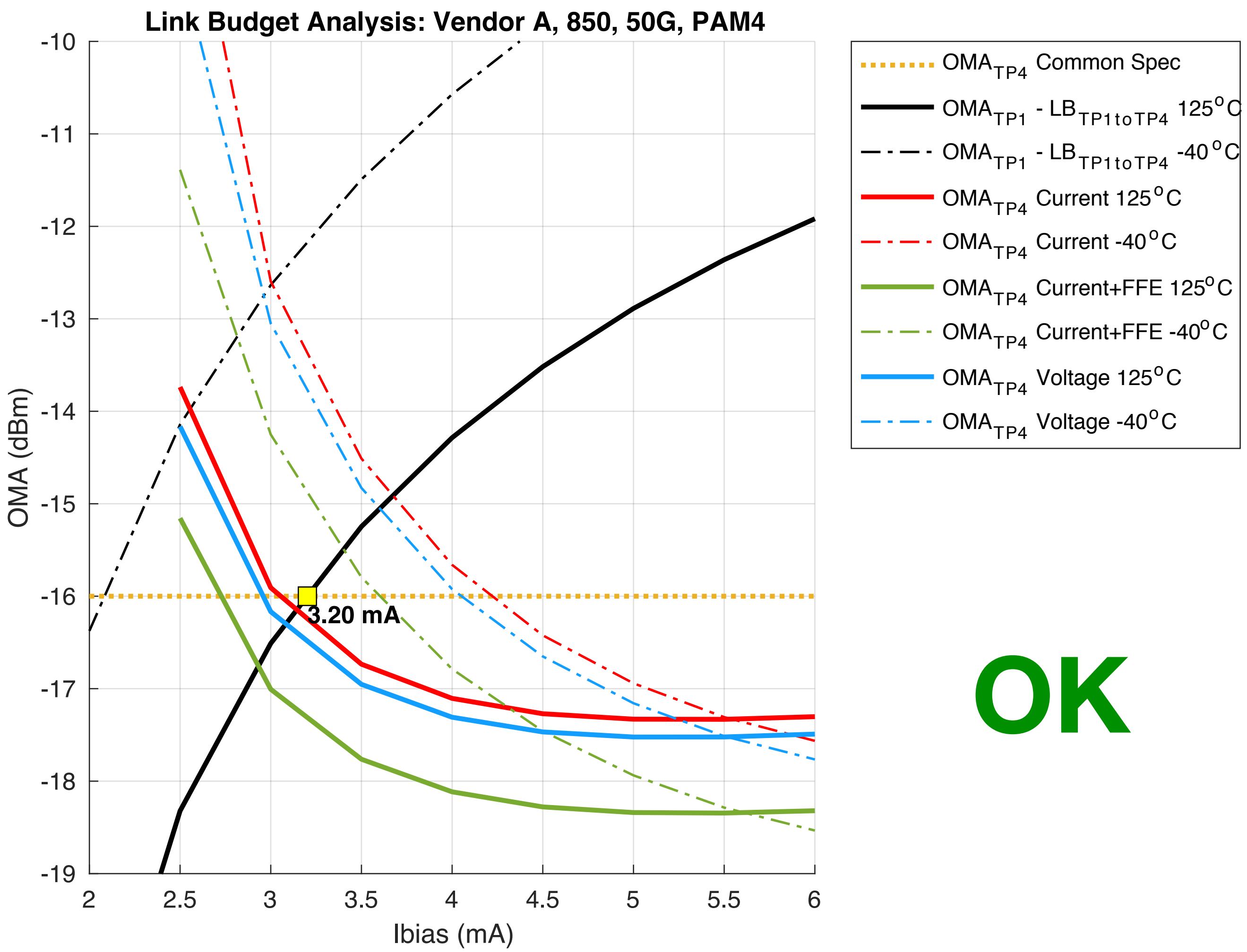
BW_{eff} = 936 MHz·km



ΔOMA_{TP4} = 0.10 dB
$\Delta I_{BIAS,min}$ = 0.03 mA
@ 125ºC

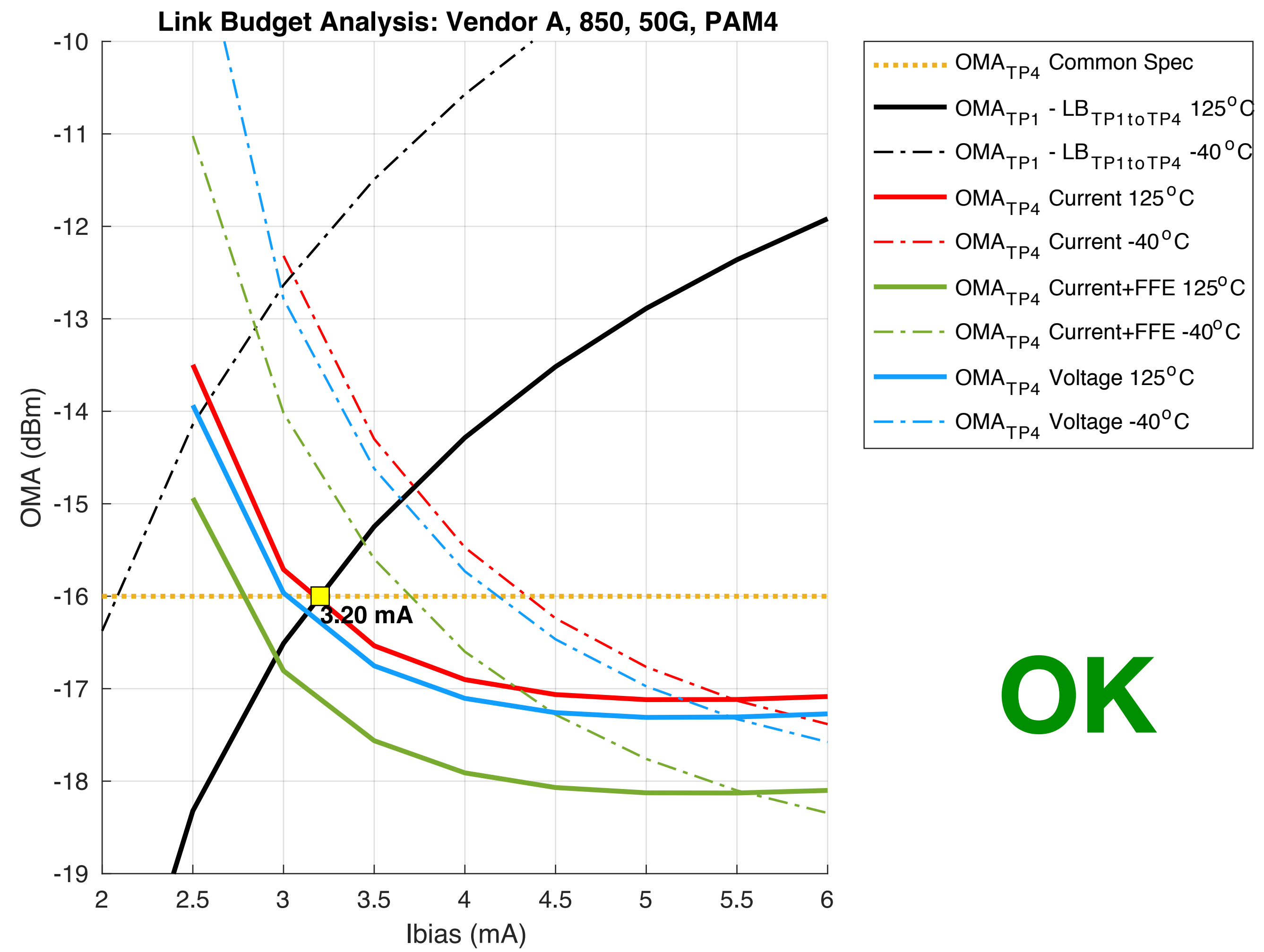
Vendor A, 850 nm, 50G, PAM4 — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



OK

BW_{eff} = 936 MHz·km

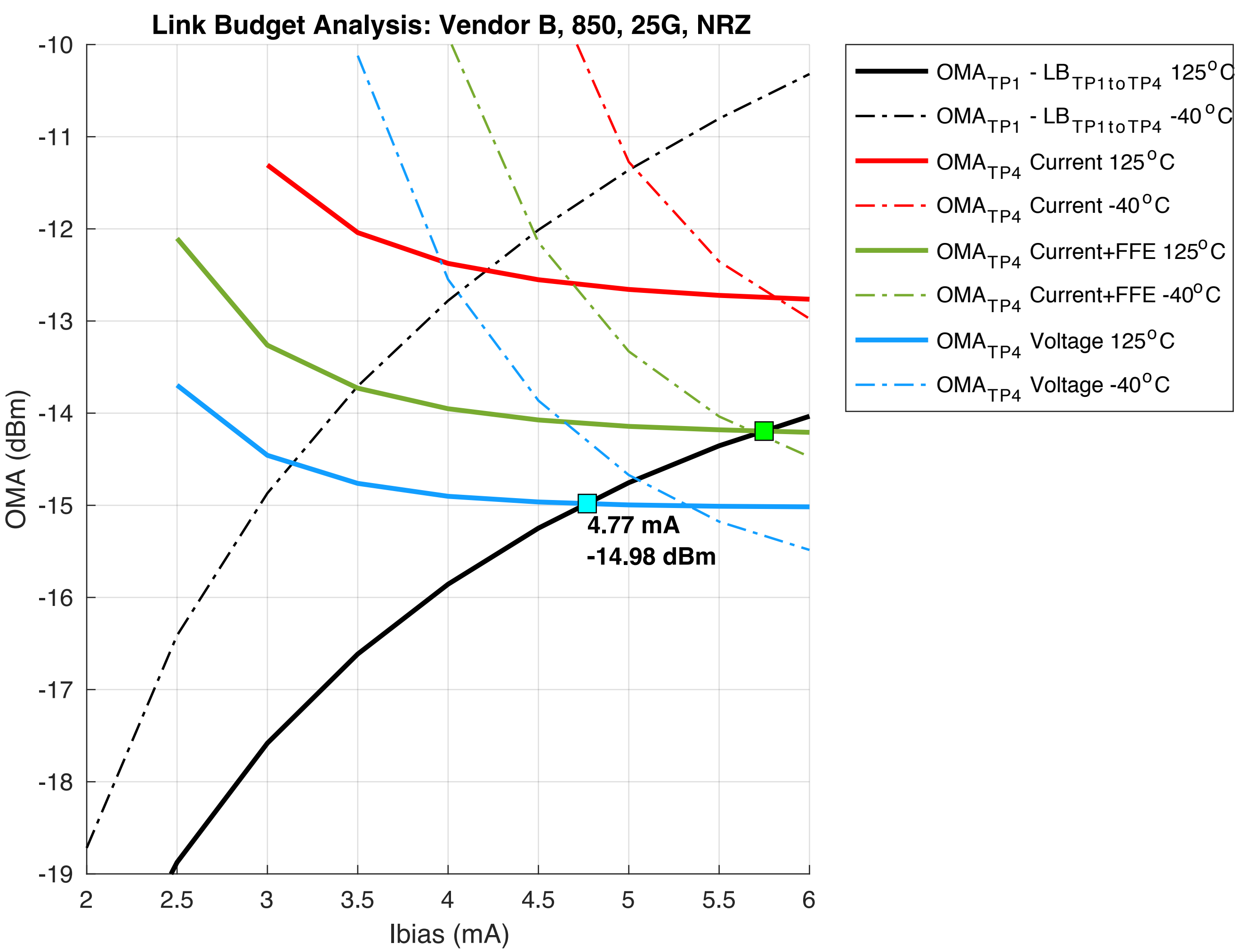


OK

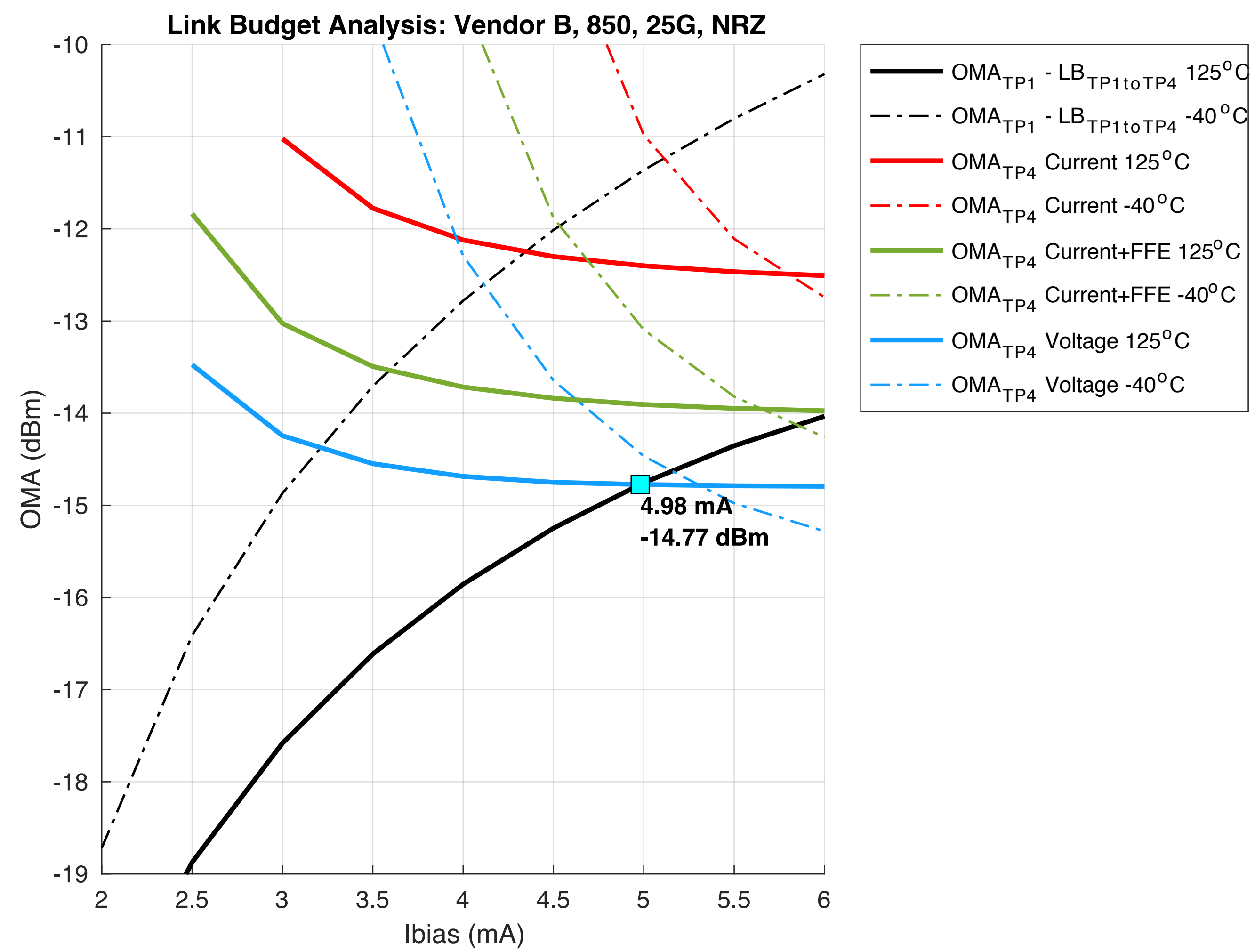
$\Delta I_{BIAS,min}$ = 0.00 mA @ 125ºC

Vendor B, 850 nm, 25G, NRZ — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



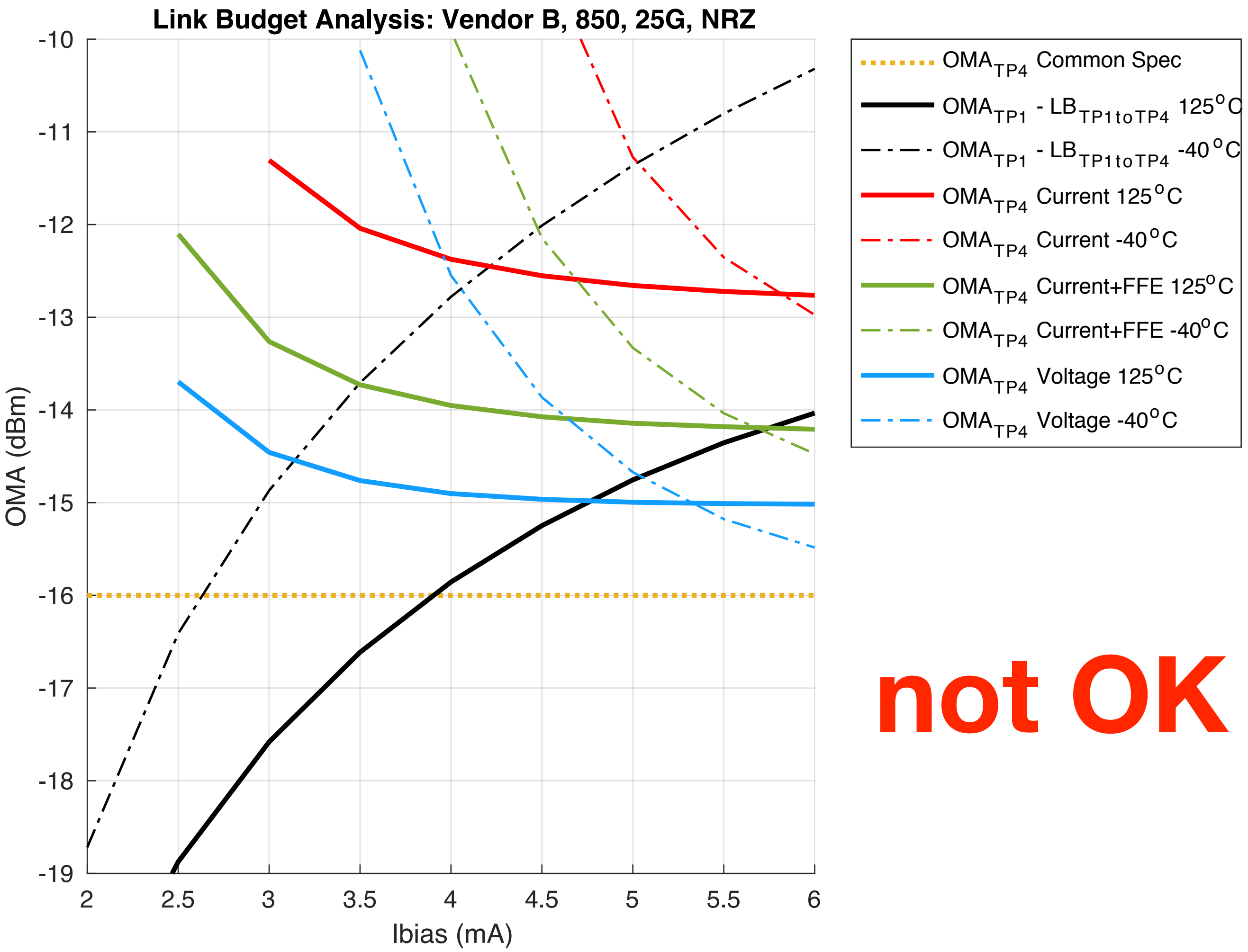
BW_{eff} = 936 MHz·km



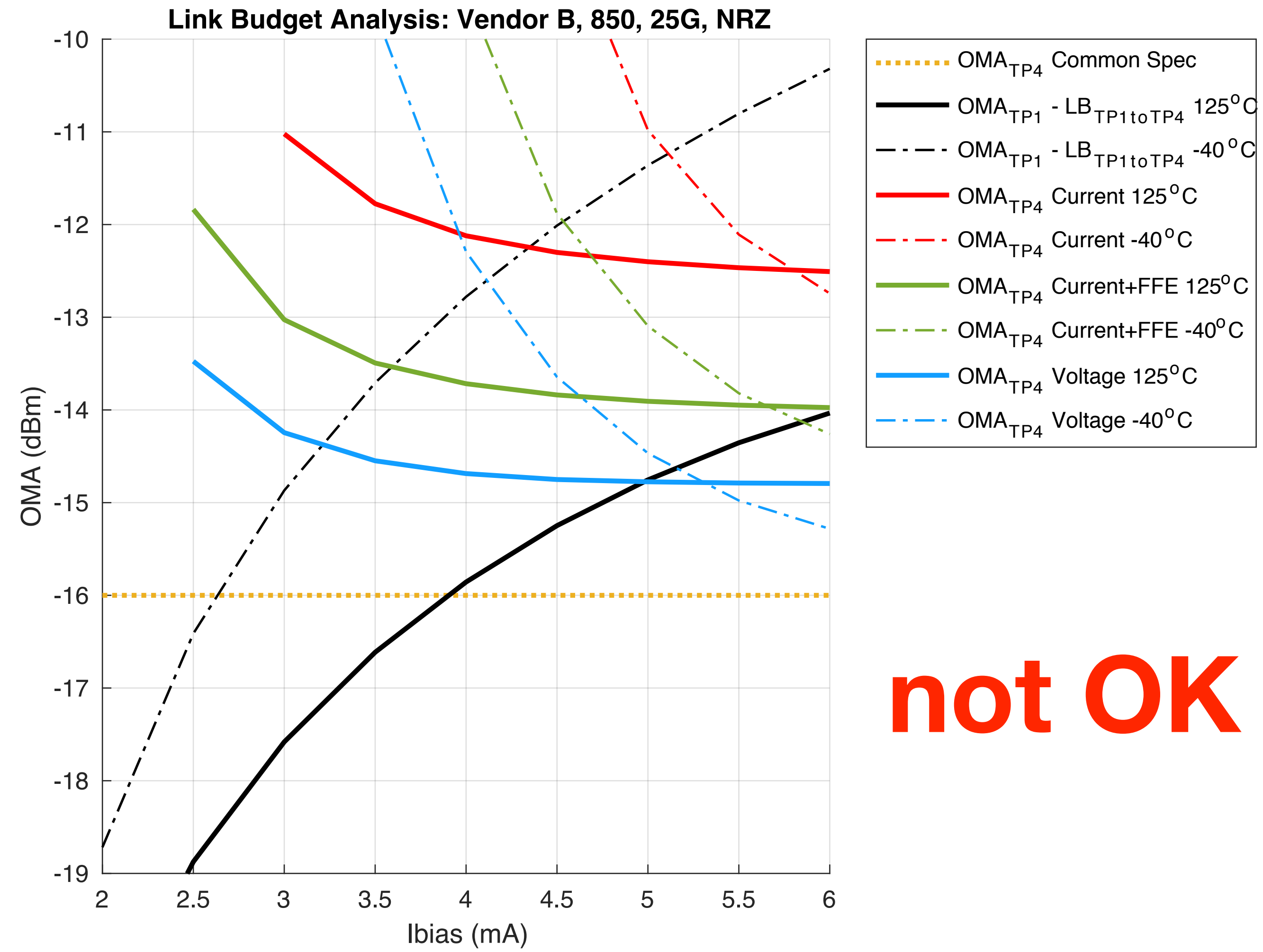
ΔOMA_{TP4} = 0.21 dB
$\Delta I_{BIAS,min}$ = 0.21 mA
@ 125ºC

Vendor B, 850 nm, 25G, NRZ — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



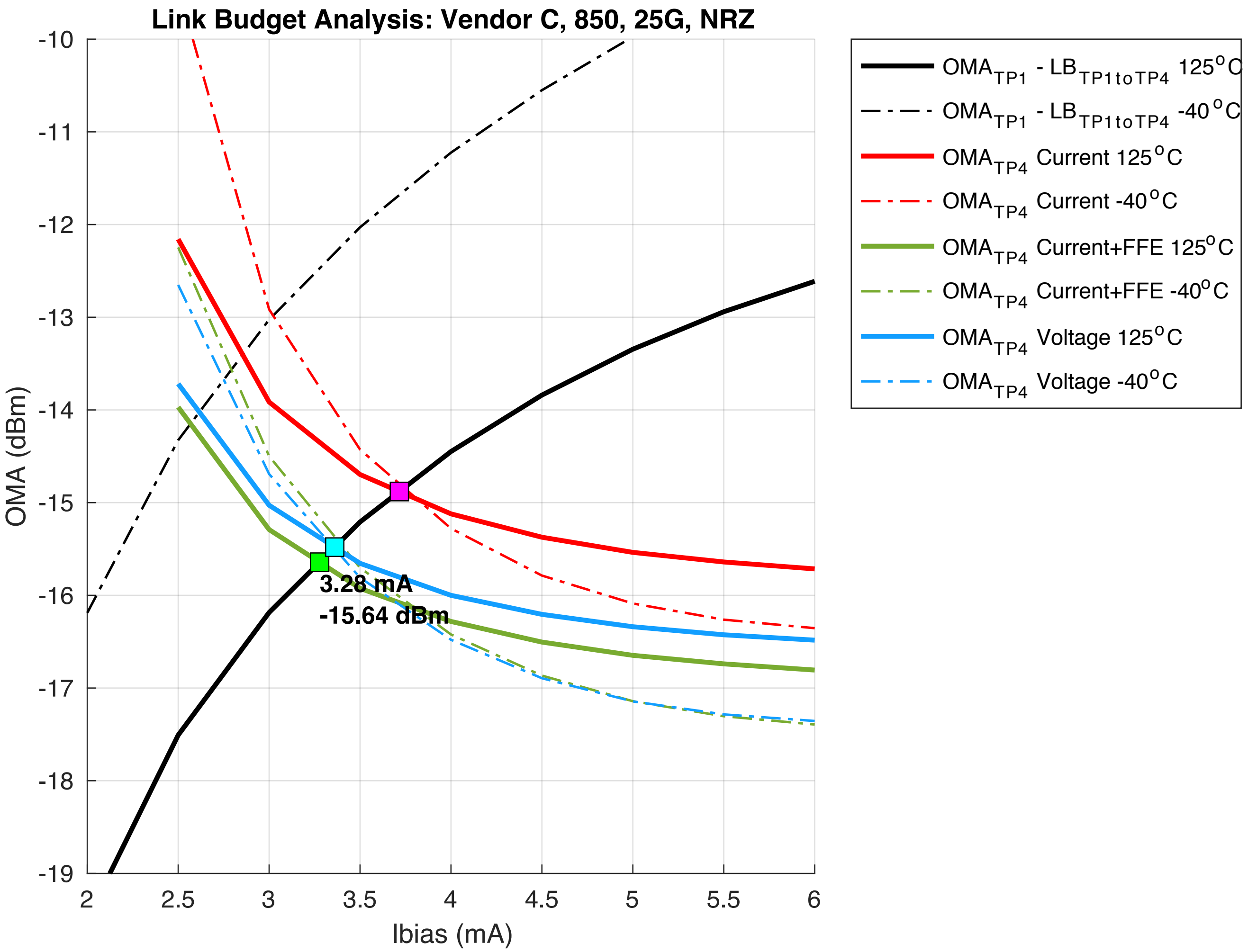
BW_{eff} = 936 MHz·km



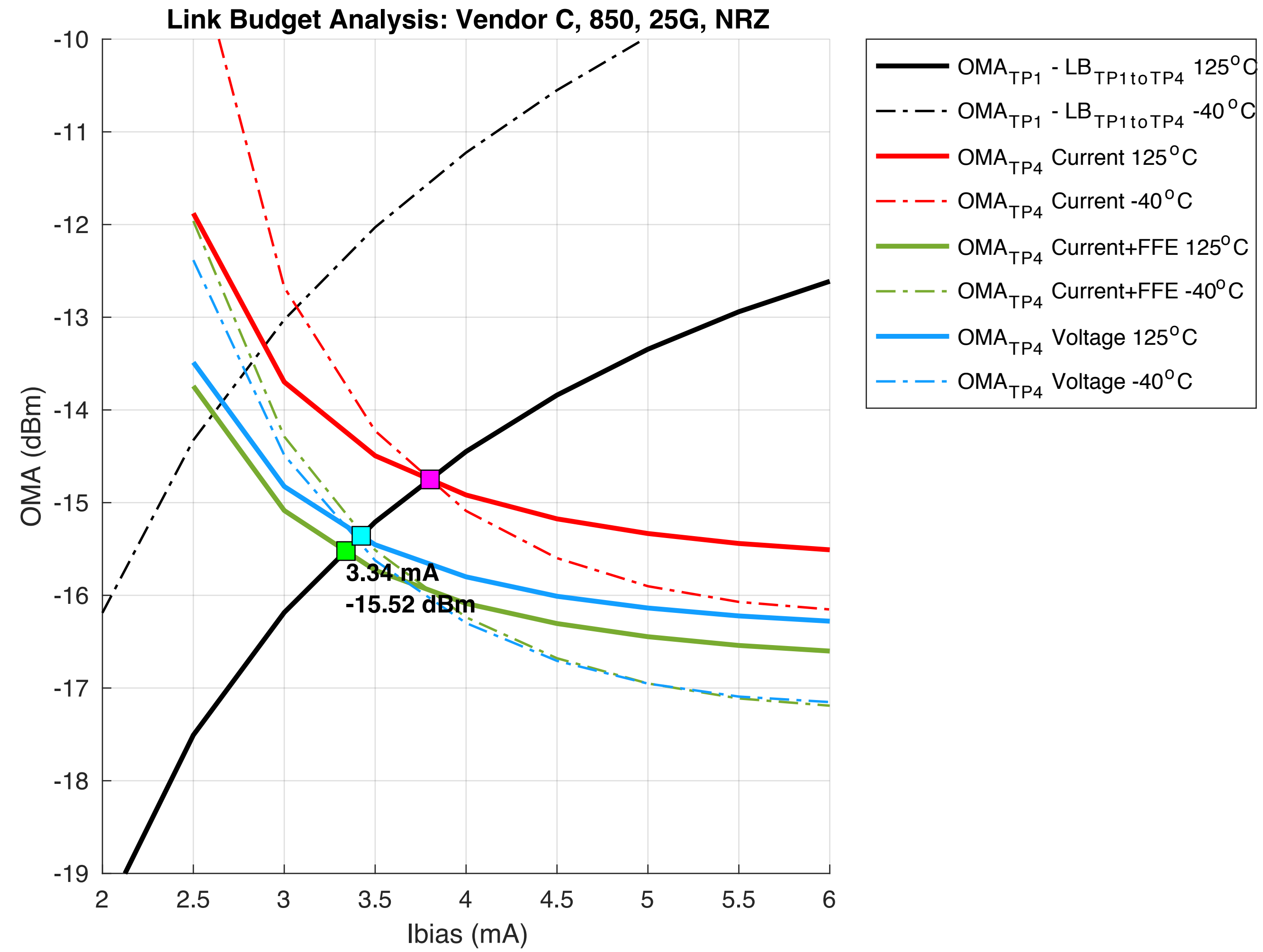
$\Delta I_{BIAS,min}$ = N/A
@ 125°C

Vendor C, 850 nm, 25G, NRZ — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



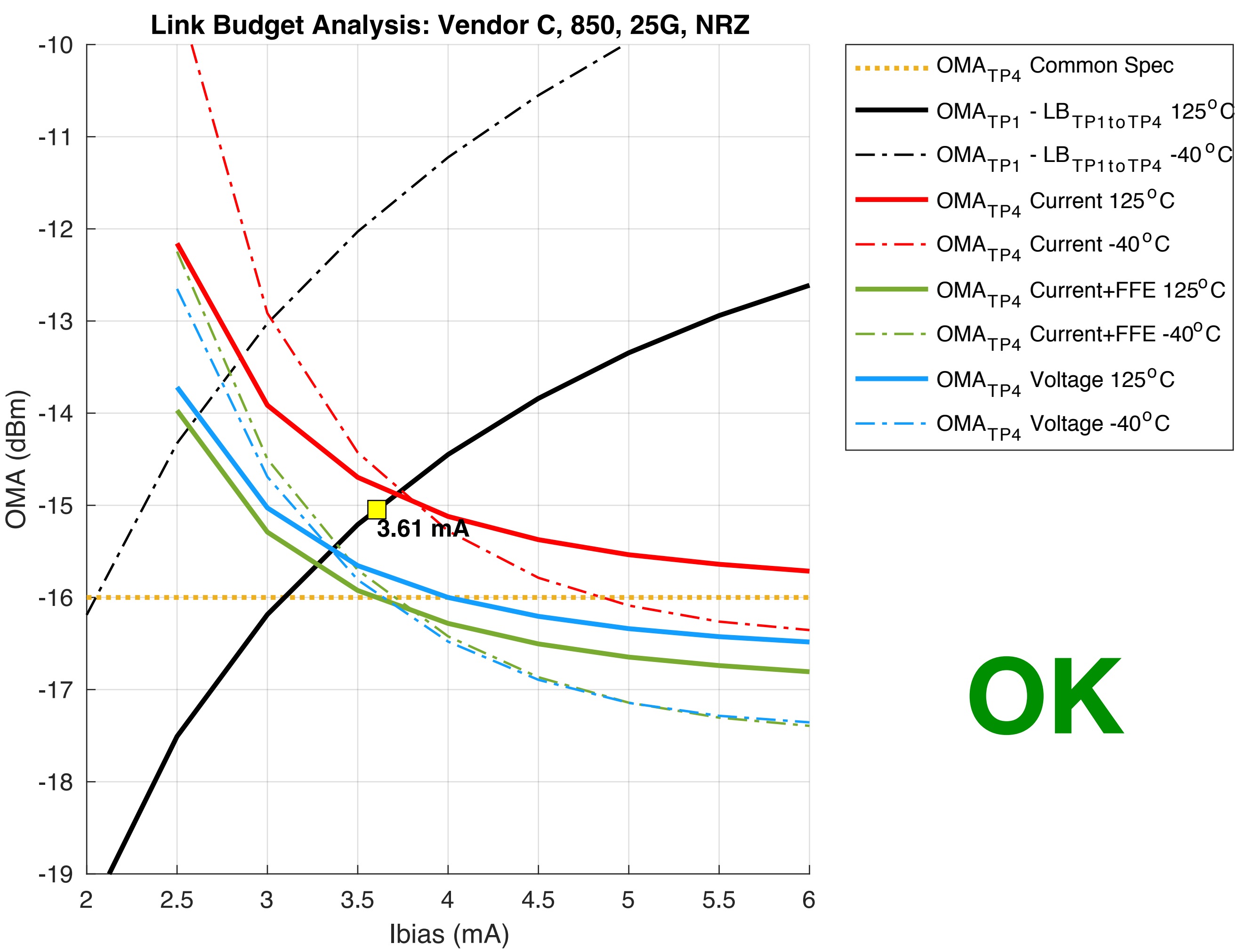
BW_{eff} = 936 MHz·km



ΔOMA_{TP4} = 0.12 dB
$\Delta I_{BIAS,min}$ = 0.06 mA
@ 125°C

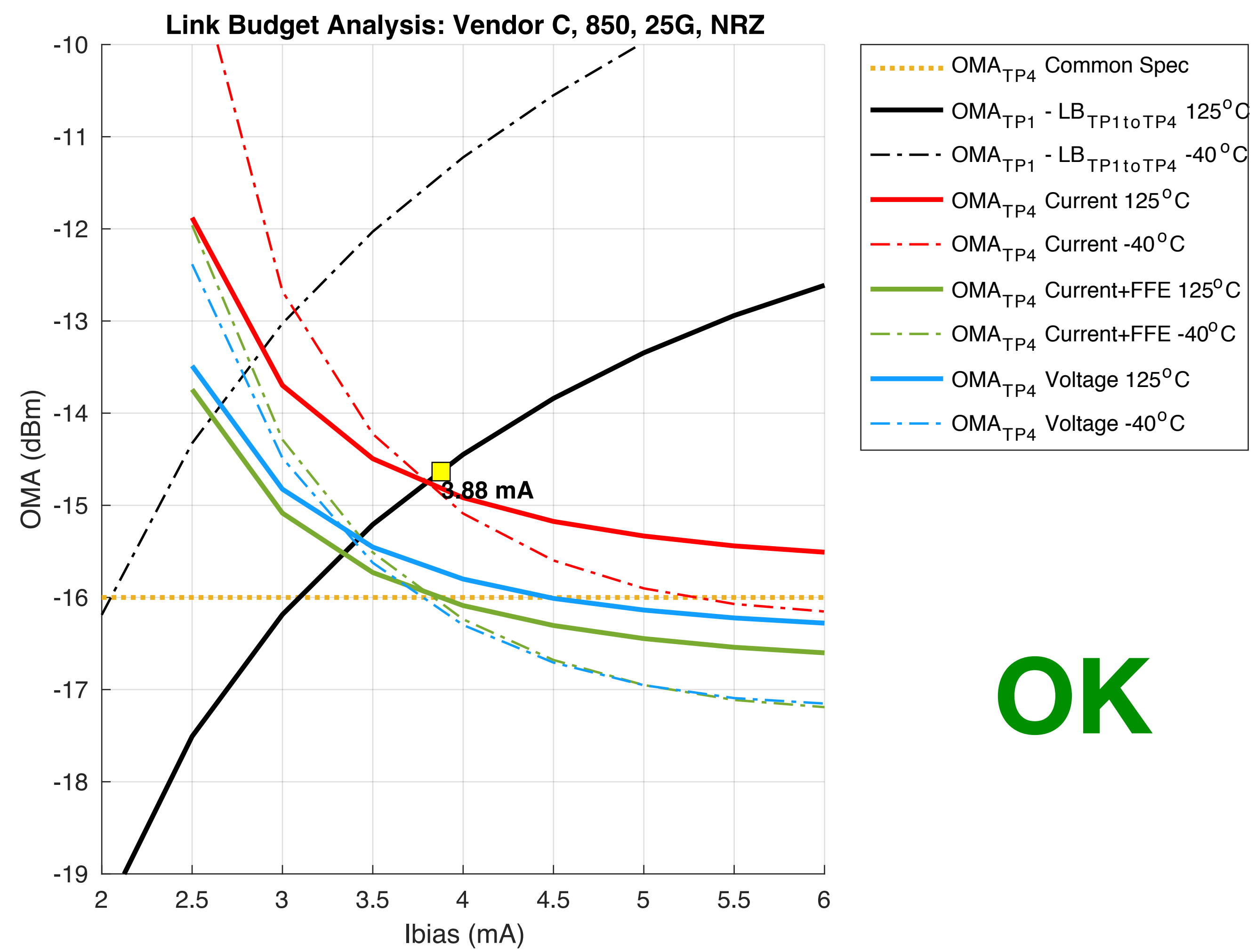
Vendor C, 850 nm, 25G, NRZ — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



OK

BW_{eff} = 936 MHz·km

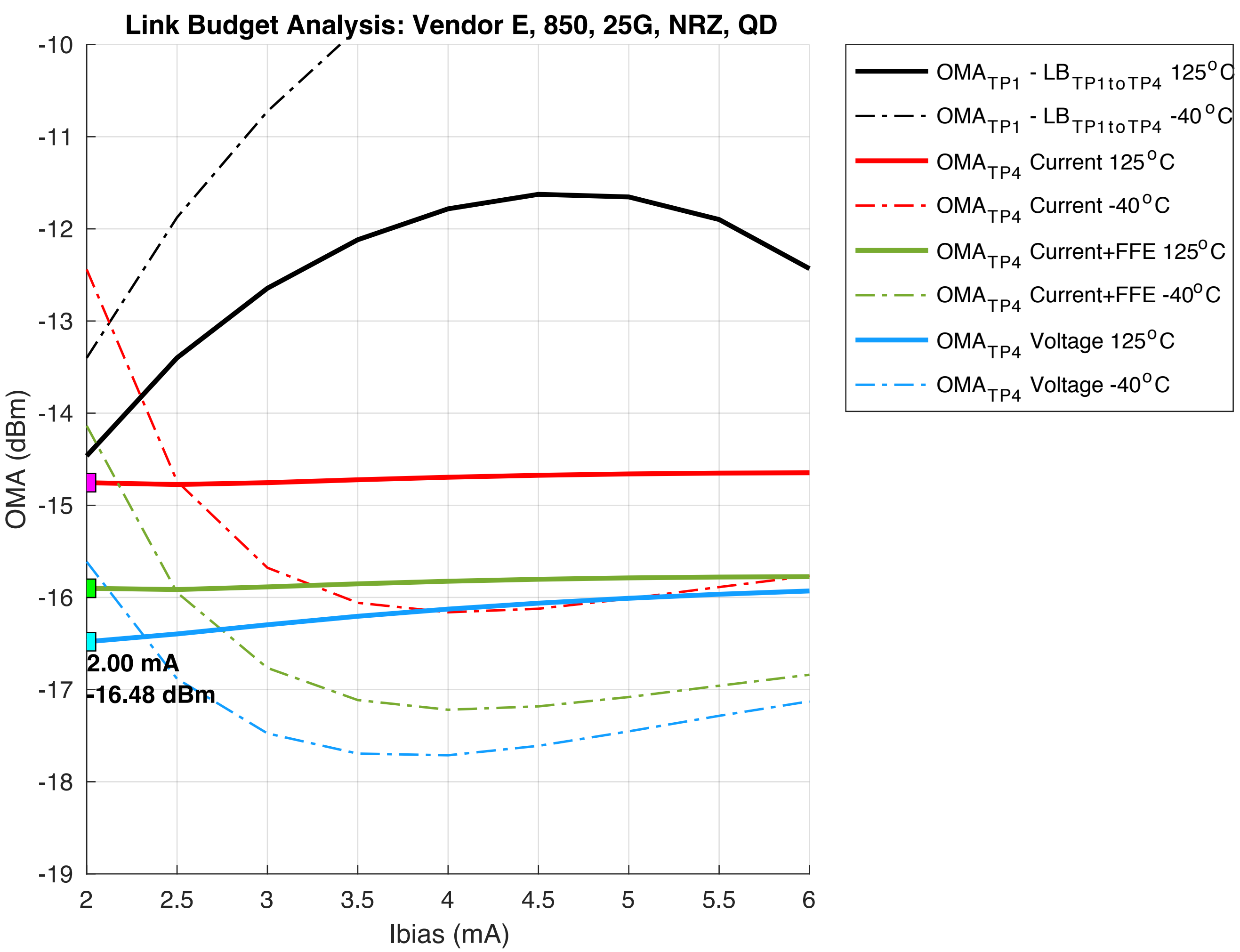


OK

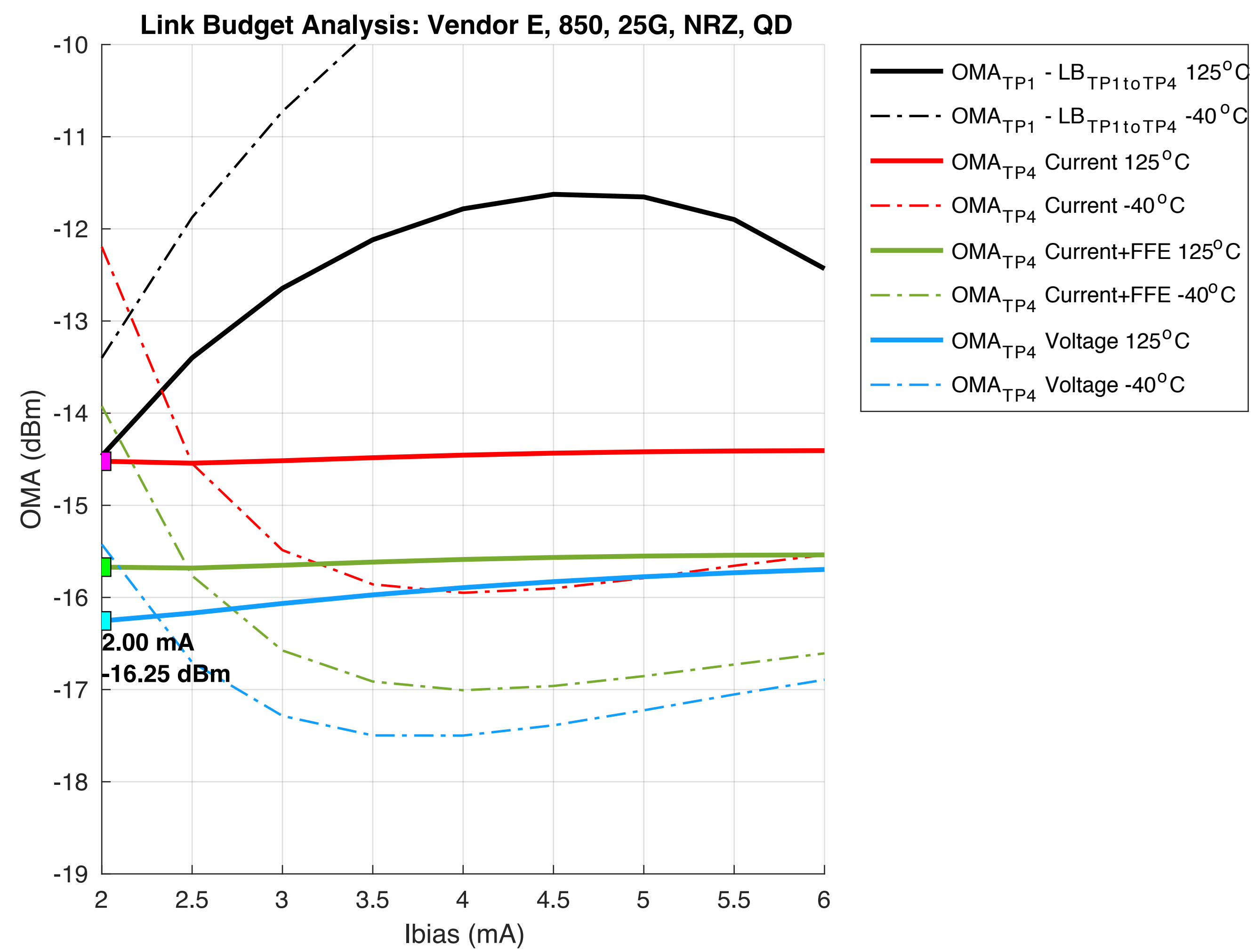
$\Delta I_{BIAS,min}$ = 0.27 mA @ 125ºC

Vendor E, 850 nm, 25G, NRZ, QD — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



BW_{eff} = 936 MHz·km



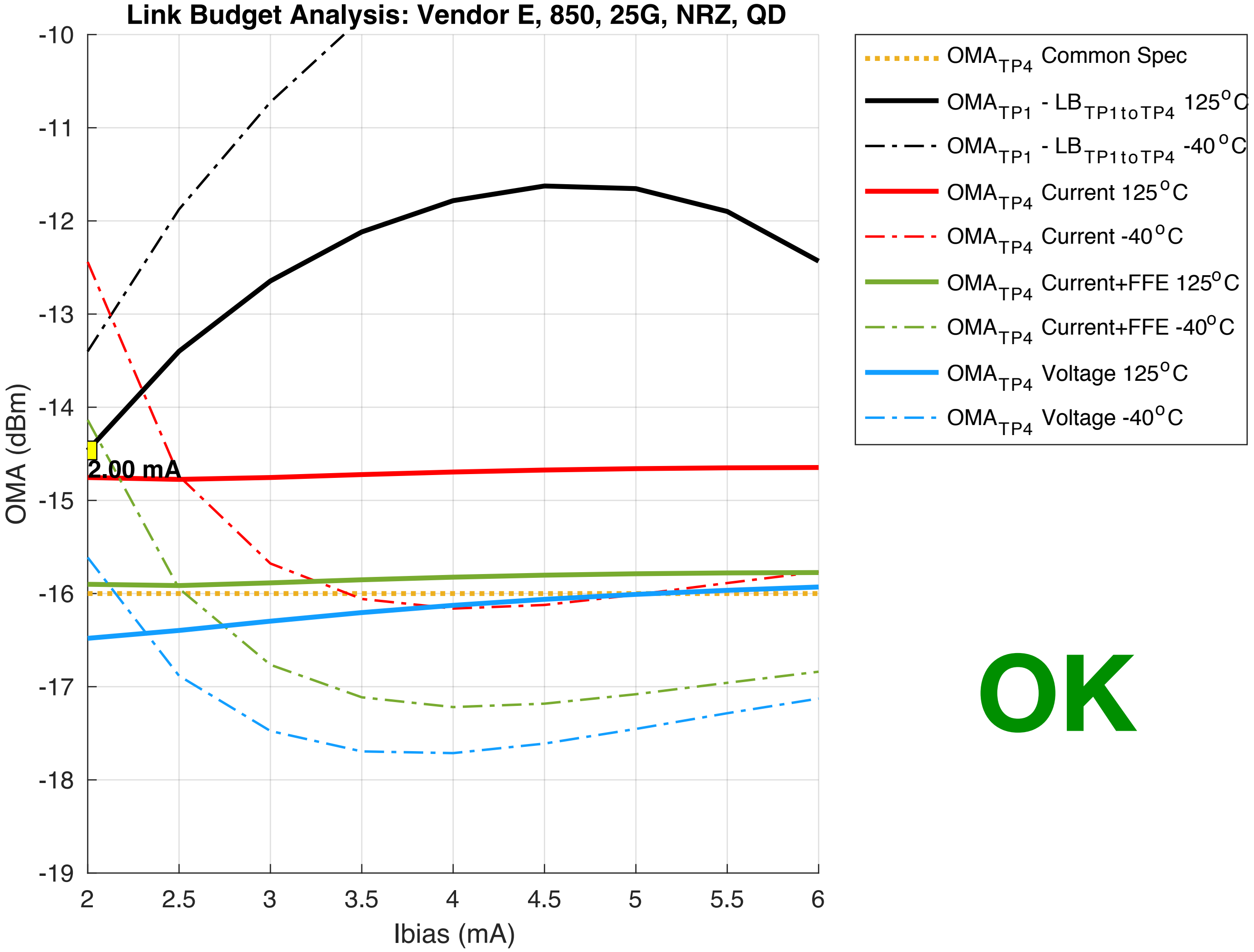
ΔOMA_{TP4} = 0.23 dB

$\Delta I_{BIAS,min}$ = 0.00 mA

@ 125ºC

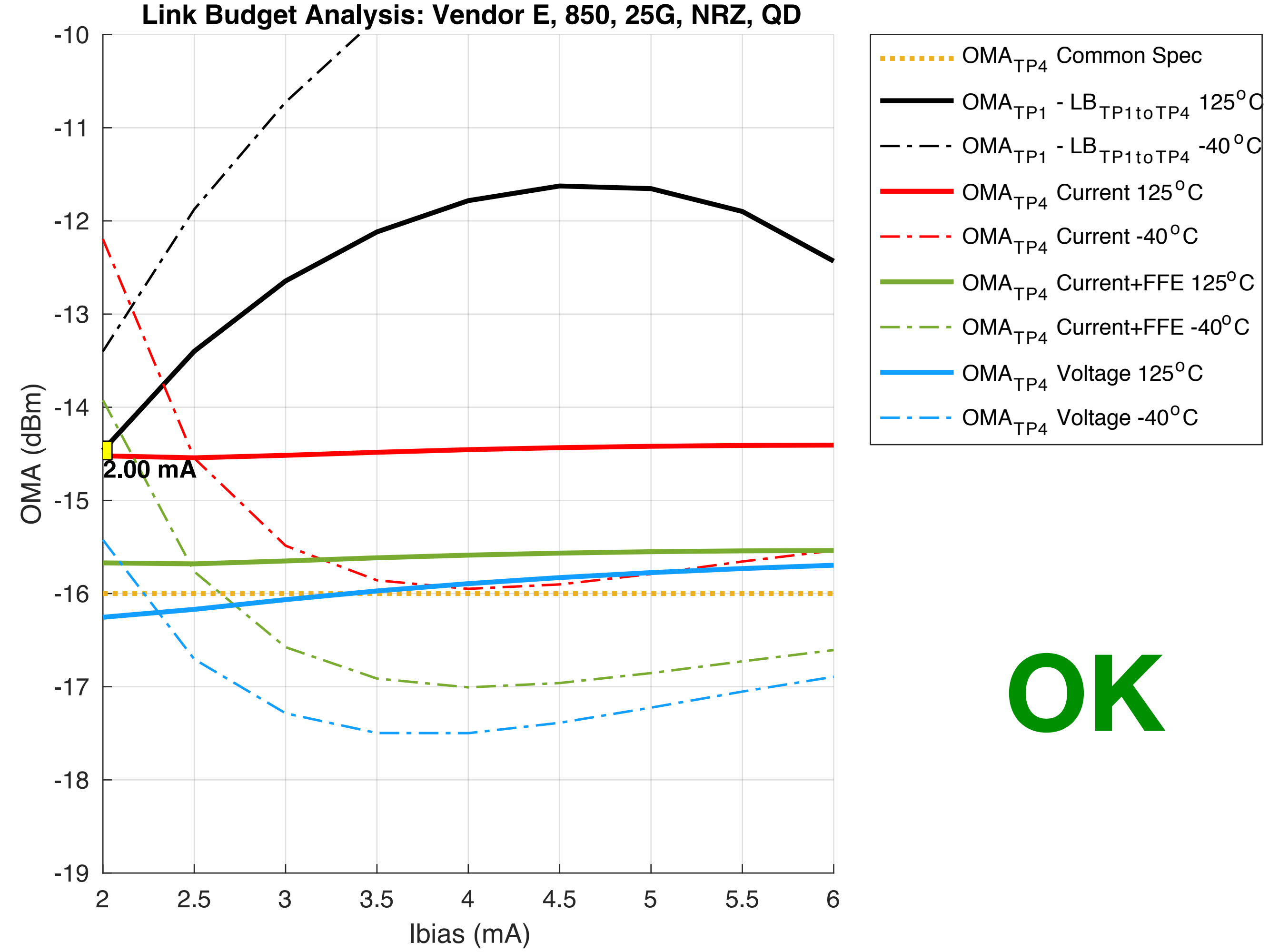
Vendor E, 850 nm, 25G, NRZ, QD — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



OK

BW_{eff} = 936 MHz·km

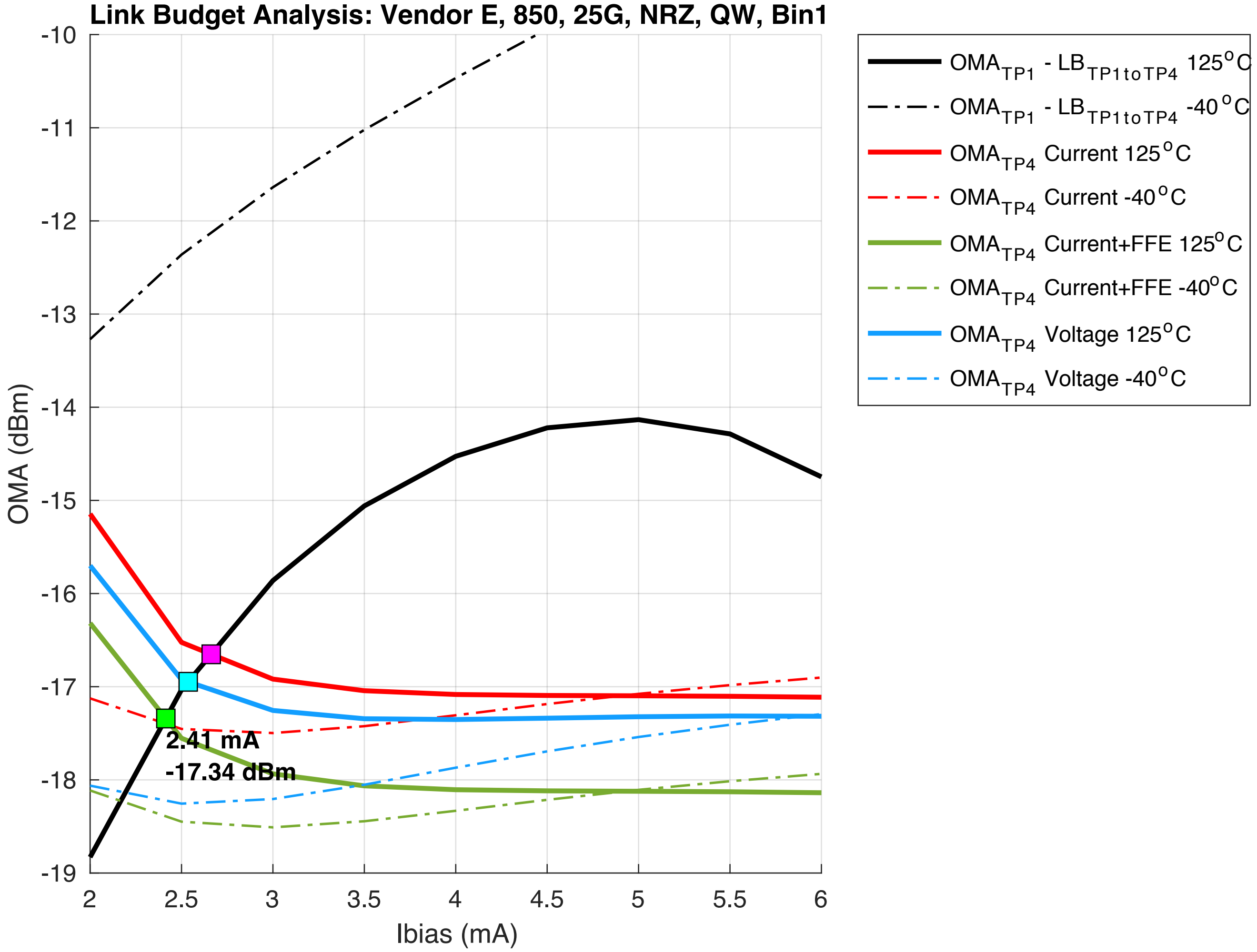


OK

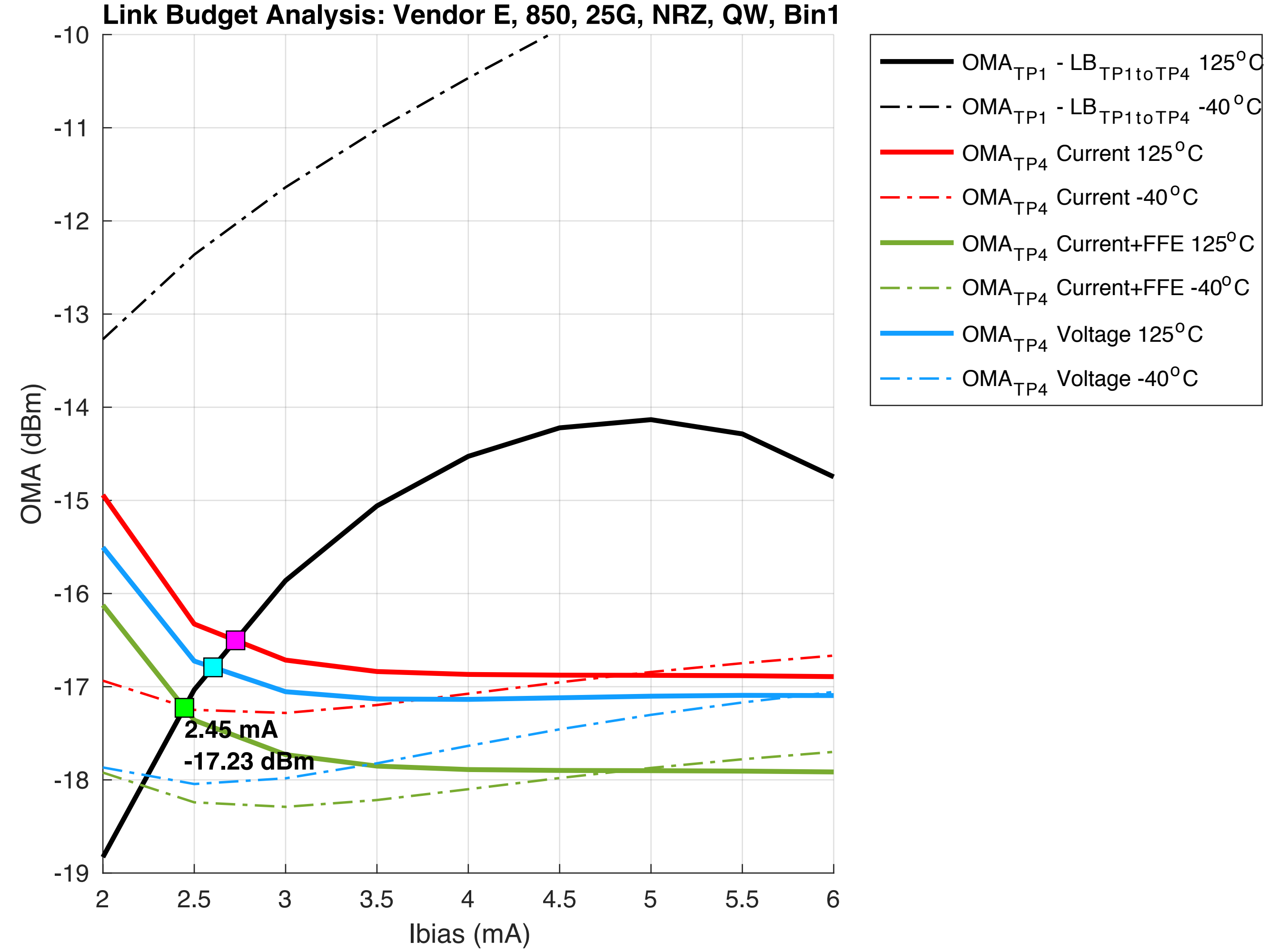
$\Delta I_{BIAS,min}$ = 0.00 mA @ 125°C

Vendor E, 850 nm, 25G, NRZ, QW, Bin1 — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



BW_{eff} = 936 MHz·km



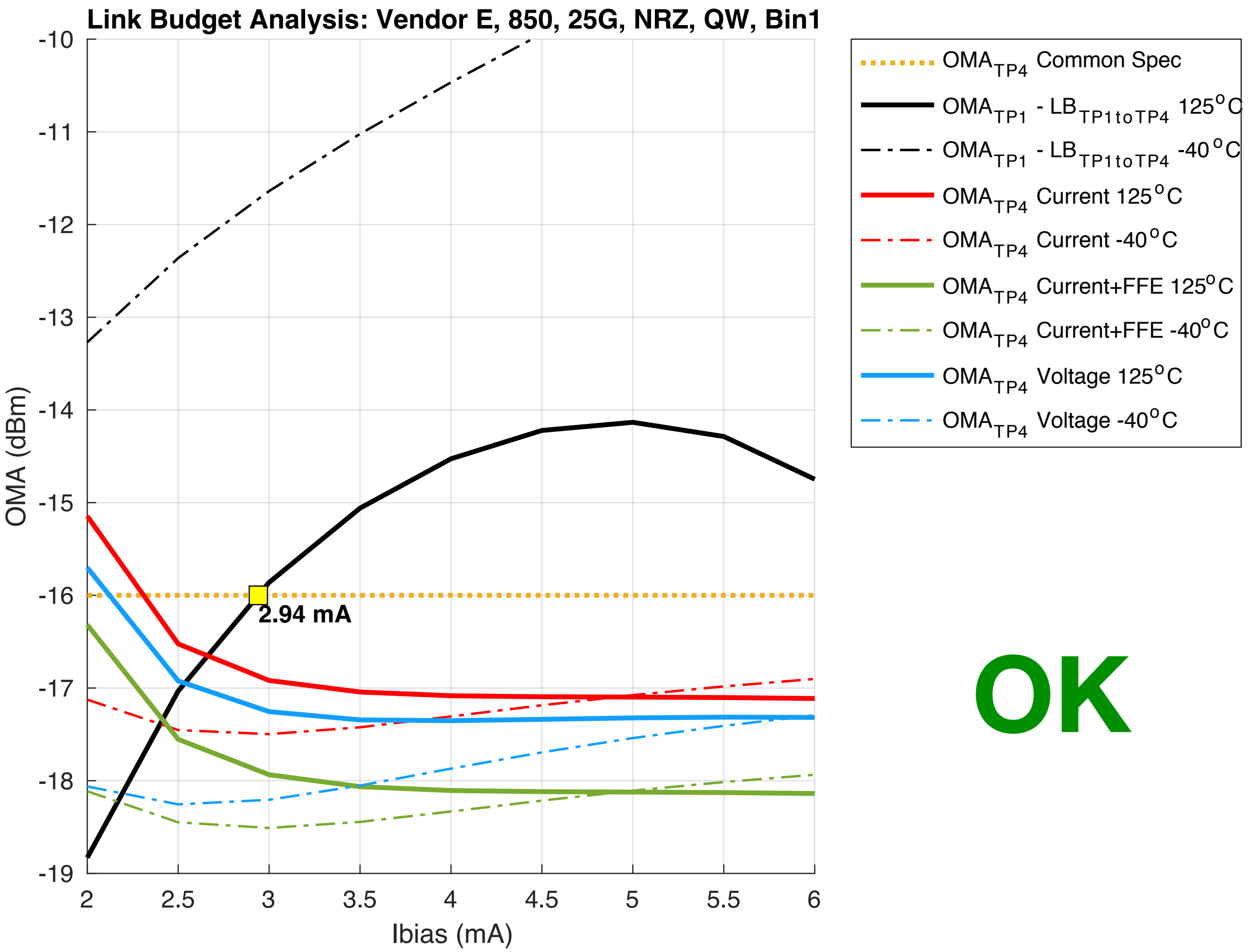
ΔOMA_{TP4} = 0.11 dB

$\Delta I_{BIAS,min}$ = 0.04 mA

@ 125ºC

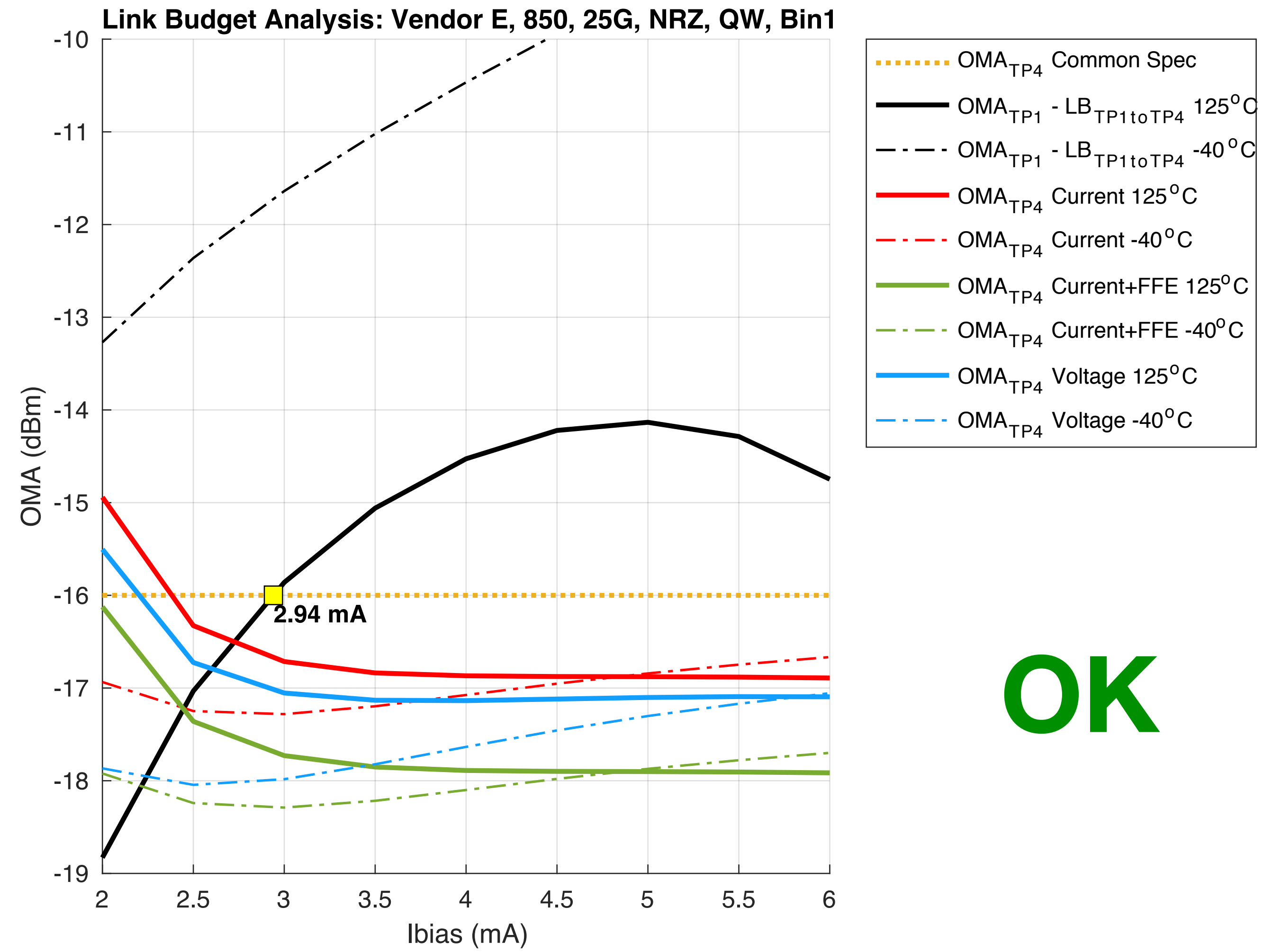
Vendor E, 850 nm, 25G, NRZ, QW, Bin1 — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



OK

BW_{eff} = 936 MHz·km

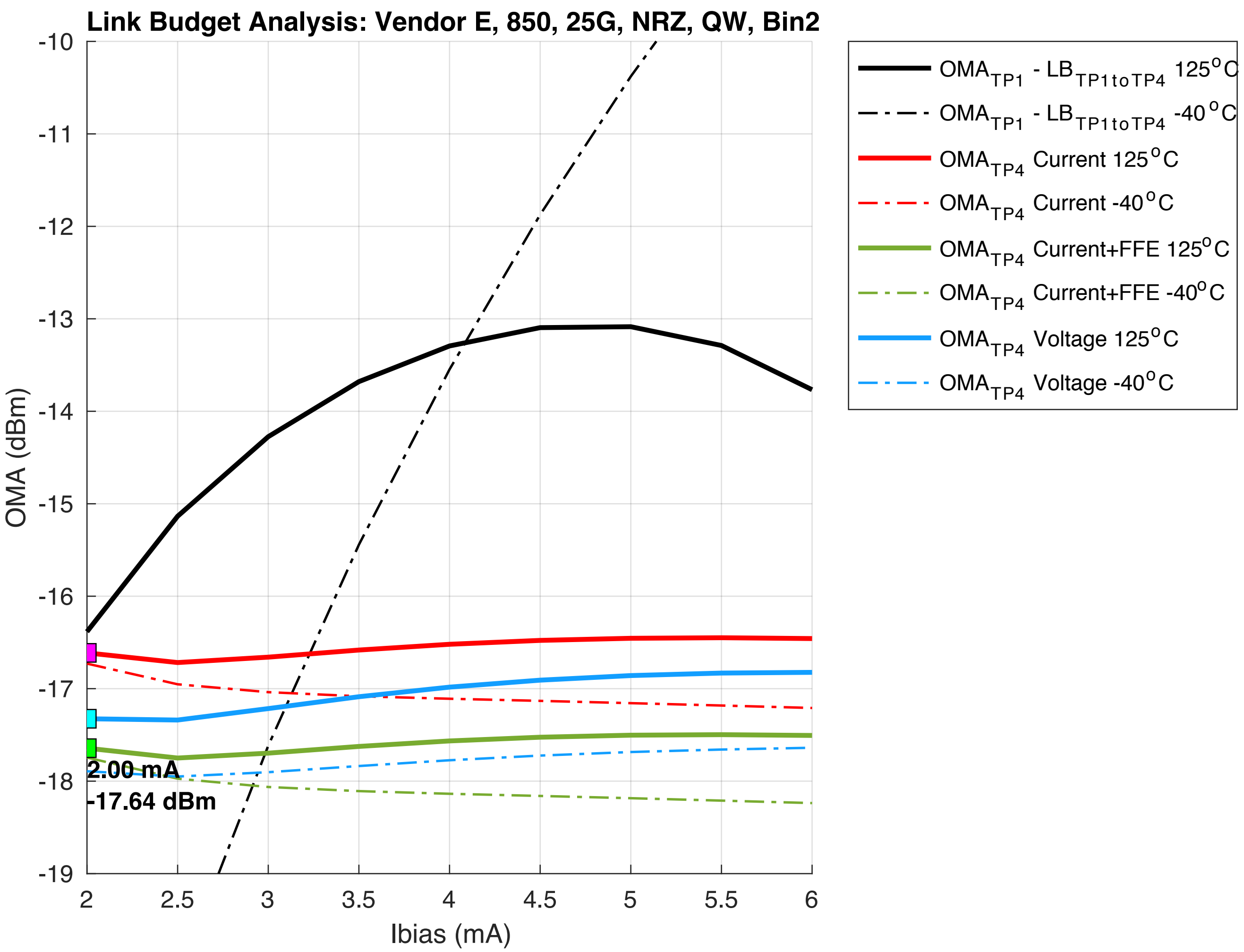


OK

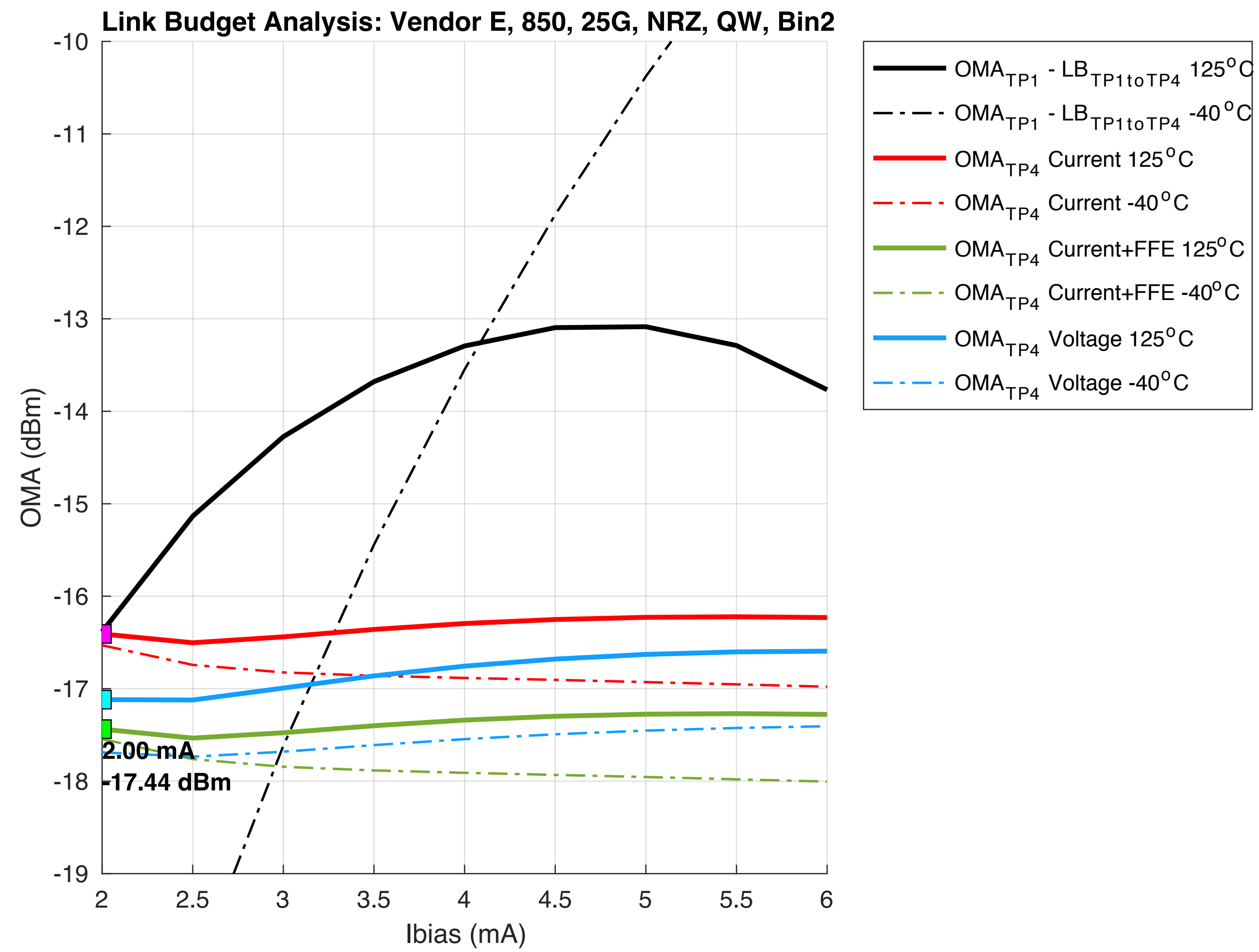
$\Delta I_{BIAS,min}$ = 0 mA
@ 125ºC

Vendor E, 850 nm, 25G, NRZ, QW, Bin2 — min OMA_{TP4}

BW_{eff} = 1665 MHz·km



BW_{eff} = 936 MHz·km



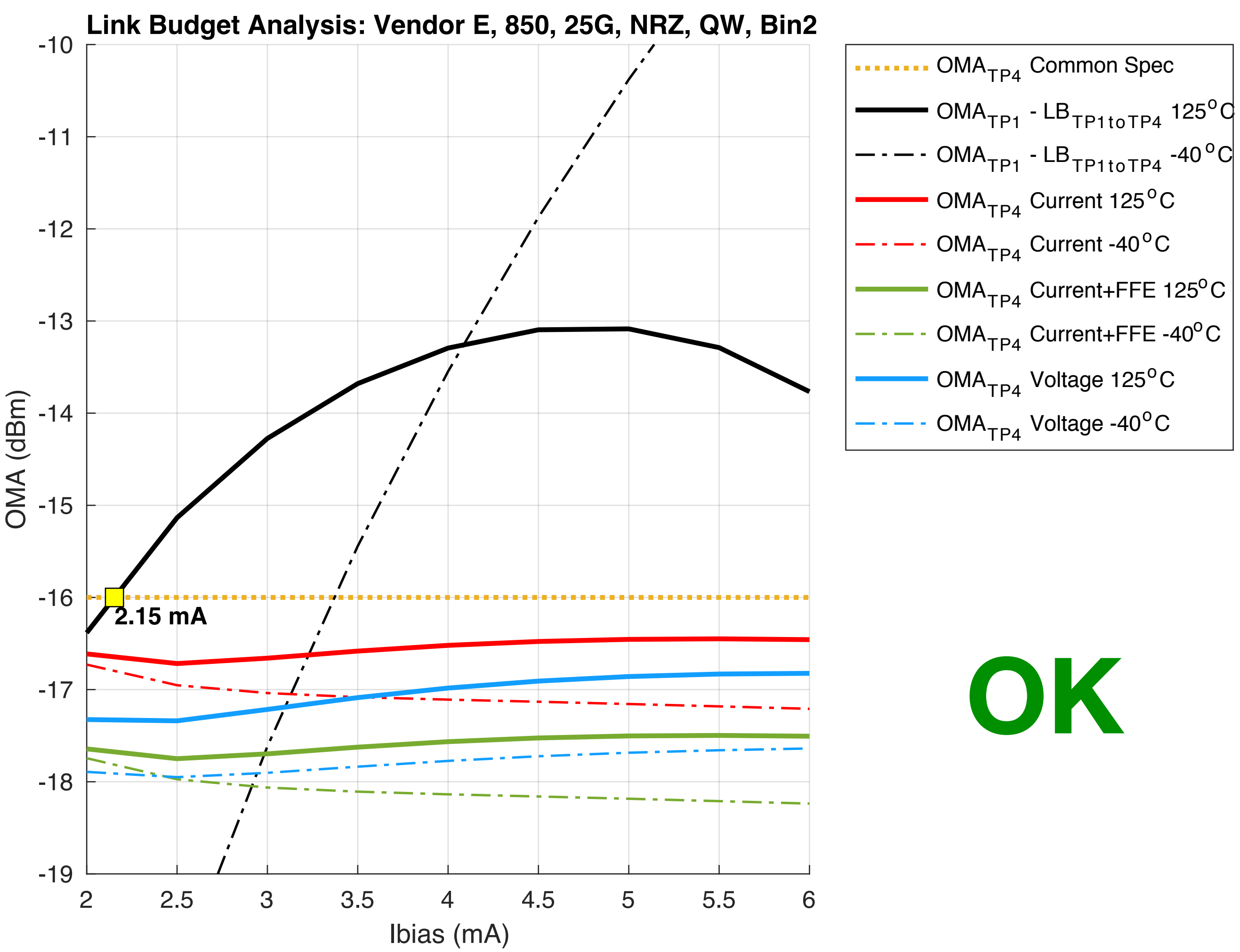
ΔOMA_{TP4} = 0.20 dB

$\Delta I_{BIAS,min}$ = 0.00 mA

@ 125ºC

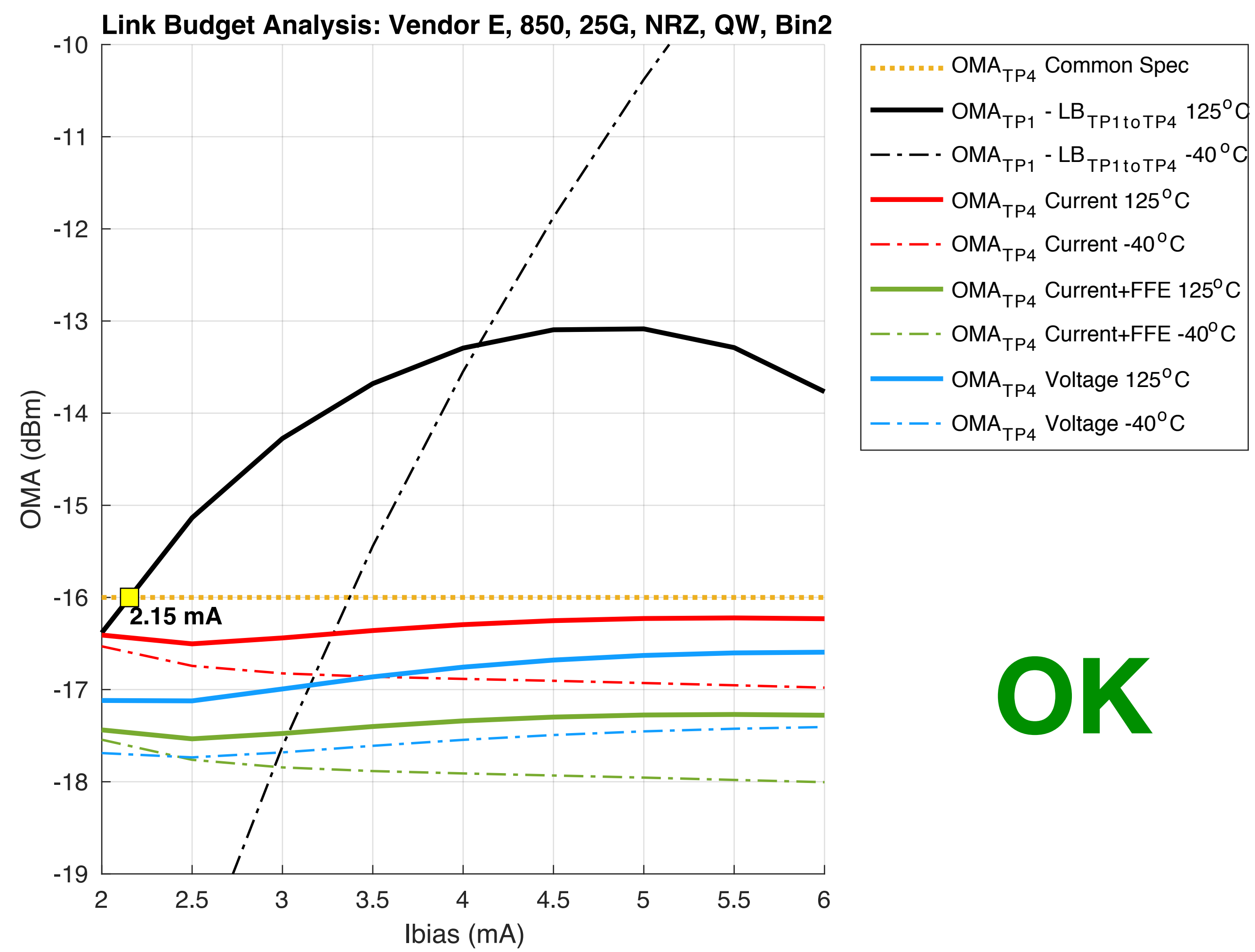
Vendor E, 850 nm, 25G, NRZ, QW, Bin2 — OMA_{TP4} = -16 dBm

BW_{eff} = 1665 MHz·km



OK

BW_{eff} = 936 MHz·km



OK

$\Delta I_{BIAS,min}$ = 0.00 mA
@ 125°C

Conclusions

- The contribution analyzed by simulation the impact in the RX sensitivity of reduced EMB equivalent to use longer wavelength VCSELs for 25 Gb/s transmission

- Sensitivity loss is **< 0.25 dB** for all the characterized VCSELs operating at 125ºC, with margin in any case for the common receiver sensitivity of -16 dBm

- Based on the reported data, it is demonstrated the use of OM3 is feasible with longer wavelengths VCSELs (e.g. 980nm) for data rate of 25 Gb/s in a fiber optic cable of 40 meters with 4 inline connections

- Because the objective for 50 Gb/s data rate is only 15 m length, the BW_{eff} of the OM3 fiber will scale as 40/15 = 2.67, which is higher than the symbol-rates factor, i.e. 2, assuming the same transmission scheme

- Based on these reasons, it is also demonstrated that the use of OM3 fibers with longer wavelengths VCSELs is not a limiting factor to meet the objective of 50 Gb/s

Thank you!