WÜRTH ELEKTRONIK

WE Standard:
WES_FIT - Reliability Data

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1 Document Control

No	Page	Change Description	Issued	Date
1	all	Change previous WE_FIT - paper to WES_FIT	MBar	04.04.2014
2	4,5	Add series WE-CMBNC	MBar	10.06.2014
3	9 - 30	Add Capacitors (Chapter 4.6), Restructure Curves	MBar	10.11.2014
4	7	Add series WE-MAPI	MBar	20.11.2014
5	5	Add series WE-ZB	MBar	02.03.2015
6	6	Add series WE-GDTI	MBar	19.05.2015
7	7	Change series WE-RJ45 into WE-RJ45 LAN	MBar	18.06.2015
8	6	Add series WE-MAIA, WE-PDA	MBar	09.12.2015
9	5,7	Add series WE-XHMI, WE-TVSP, WE-PMMI, WE-PMCI, WE-TIF	COt	25.01.2016
10	4 - 7	Add series WE-UCF, WE-ExB, WE-FCL, WE-GFH, WE-FAMI, WE-PoEH, WE-LLCR, WE-CAIR	COt	06.06.2016
11	3	Update the text of chapter 3.1; Update the temperature of chapter 8.b	COt	21.07.2016
12	13	Change part description	HaK	19.10.2016
13	7 - 15	Add series WCAP-CSMH, WCAP-FTBE, WCAP-FTBP, WL-SBRW, WL-SBSW, WL-SFCD, WL-SFCW, WL-SFRW, WL-SFSW, WL-TIRW, WL-SIMW, WL-SUMW, WE-LQSH, WE-LQFS, WE-KIHC, WE-PD2SA	COt	03.11.2016
14	7 - 10	Add series WL-SBCW, WE-LAN AQ, WE-PDeco, WE-HCLW	COt	01.09.2017
15	5 - 7	Add series WE-CMBHV, WE-LPCC, WE-DPC, WE-DPCHV, WE-FLEX HV, WE-RJ45 10G, WE-CHSA, WE-TIeco	COt	11.07.2018
19	4 - 32	Add series WL-SFTD, WL-SMCD, WL-SMCC, WL-SICW, WL-SISW, WL-SIRW, WL-SITW, WL-SMDC, WE-RCIT, WE-RCIS, WE-LHCA, WE-TPB, WE-TPBHV, WE-XTAL, WE-SPXO	COt	05.12.2018
20	all	Add series WE-LQS Eco, WCAP-CSST, WCAP-CSRF, WCAP-STSC, WCAP-PHGP, WCAP-PHET, WCAP-PHLE, WCAP-PHSE, WE-LAN 10G, WCAP-ATLL; Update of the Capacitor: change the Unit from mF to µF; Implementation of Resistance	COt / TKa	13.05.2019
21	7,12, all	Add series WE-HCFA, WE-HCIT, WL-STCB, WL-STCW,WL-STRB, WL-STSW, WL-STTB, WL-SDCB, WL-SDSB, WL-TDRW, WL-TDRB Re-format tables for easier reading.	TKa	17.07.2019
22	12	Update graphs 5.7, 6.7 to be more precise; Correct typographical errors; Add series WE-HIDA, WE-LHMD, WL-SBCD, WL-SFCC, WL-STSB, WL-STTW, WL-TTRB, WL-TTRW, WE-STST, WE-CLFS, WE-CCMF, WE-RJ45 LAN TH Reflow; Add Section 4.9 Connectors, Add graphs 5.11-5.15, 6.11-6.15; Correct the classification of aluminum polymer cap series WCAP-PTG5, -PTHR, -PTHT, -PT5H, -PSLC, -PSLP, -PSHP, -PHGP, -PHLE, -PHSE and -PHET to Unlisted.	TKa	18.11.2019
23	6, 8, 12, 13, 19, 20	Correct the classification of WE-CBA, -CBF, -CBF HF, -MPSB, - PBF, -PF and -TMSB from 'Coil, Chip/Ceramic Filter' to 'Coil, Ferrite Beads' (FIT rate is unaffected); Add series WE-MCRI, WE-MTCI, WE-MPSA, WL-OCPT, WL-TIRC; WP-BUCF, WP-BUFU, WP-BUTR, WP-RAFU, WP-RATR, WP-SHFU, WP-TGCF, WP-TGTR, WP-TPSE, WP-SMBU, WP-SMSH, WP-SMRT, WP-THRBU, WP-THRSH; Add section 4.10 MagI^{3}C Power Modules	TKa	10.07.2020

No	Page	Change Description	Issued	Date
24	5, 6, 8-13, 24, 36, 39	Add series WE-ACHC, WE-AGDT, WE-BMS, WE-CMDC, WE-HCFT, WE-MCI, WL-SIQW, WL-VCSL, WL-SMTD, WL-S7DS, WL-T7DS; Re-classify WE-CAIR; Remove WE-TFCH; Add Custom CMC, Custom Power Inductor, Custom Power Transformer, Custom LAN, Custom Signal Transformer	TKa	27.10.2020
25	4-6, 11, 14, 15, 17, 21-57	Add series WE-FCLP, WE-LANMX; Change classification of WRIS-xxxx and WCAP-Pxxx series; Update FIT rates for WE-RJ45 LAN, WE-RJ45 LAN TH Reflow, WE-RJ45LAN 10G, and WL-OCPT; Relabel curves; Add graphs 5.16, 5.17, 6.16 and 6.17; Update sections General Information, UCL and FAQ	TKa	17.06.2021
26	5-9, 12, 13, 18-20, 31-35, 48-52, 56	Add MagI³C-VDMM 171930601; Add series WE-CHSAP, WE-CLFS Low Leakage, WE-CNSA, WE-HCIA, WE-XHMA, WL-OCDA; Combine sections EMC (1) and EMC (2); Add informational text in Section 4.5; Section 8.2: Correct typo from “114 years” to “114k years”; Remove most connectors due to high variability and add explanation.	TKa	07.02.2022

2 General Information

Through this document Würth Elektronik provides FIT data for parts of our portfolio. The FIT data is shown for each product series of a product family. The product series name for a specific product is found on the datasheet of each product.

The provided reliability values are based on the calculation models of Telcordia SR-332 Issue 3, except for section 4.10. The reliability values in section 4.10 are based on MIL-HDBK-217F and supported by reliability testing. All given FIT values are based on an operating time of 10^9 hours.

WE provides the following values:

- FIT – λ : Mean Device Failure Rate
- FIT – σ: Standard Deviation of Failure Rate

As you can see in the curves within the graphs 1 - 17 and the example in Chapter ***“Upper Confidence Level Calculation”***, the increase of temperature directly influences the initial FIT data (λ /σ). Please keep in mind that the usage of a component in a higher operating temperature will increase the FIT values and may shorten the effective product life. Thus the design of your application and the related operating temperature will have a direct influence on the reliability of the used components. So directly during the design stage the base factors for later product / module reliabilities are being set.

3 Determination of FIT values

If you need a FIT value for a specific product, then please follow the procedure described below:

1. Find the product series name on the product datasheet. Look up the FIT rate for this product series using the tables in Chapter ***4***.
2. Within the table columns FIT – λ and FIT – σ, you can find the graph (numeralized) and the curve (alphabetized) where you can look up the desired FIT – λ and FIT – σ values.
3. Go to the specified graph for the desired values at the operating temperature of your application.

WARNING: The maximum allowed operating temperature can be less than 125°C. Please check the specific Data Sheet. For each product the maximum operating temperature given in the datasheet is obligatory.

4 Product Series Mappings to Graphs

4.1 EMC Components

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-CMB	Coil, Power Filter	**5.1**	**B**	**6.1**	**d**
WE-CMB HC					
WE-CMB NiZn					
WE-CMBH					
WE-CMBHV					
WE-CMBNC					
WE-CMDC					
WE-CNSA					
WE-CNSW					
WE-CNSW HF					
WE-ExB					
WE-FC					
WE-FCL					
WE-FCLP					
WE-FI					
WE-LF					
WE-LF SMD					
WE-LPCC					
WE-RCIS					
WE-RCIT					
WE-SCC					
WE-SD					
WE-SL					
WE-SL1					
WE-SL2					
WE-SL3					
WE-SL5					
WE-SL5 HC					
WE-SLM					
WE-TFC					
WE-TPB					
WE-TPBHV					

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-UCF	Coil, Power Filter	**5.1**	**B**	**6.1**	**d**
WE-ZB					
Custom CMC					
WE-CBA	Coil, Ferrite Beads	**5.1**	**C**	**6.1**	**d**
WE-CBF					
WE-CBF HF					
WE-CMS					
WE-MI					
WE-MLS					
WE-MPSA					
WE-MPSB					
WE-PBF					
WE-PF					
WE-SUKW					
WE-TMSB					
WE-UKW					
WE-WAFB					

			FIT - λ		FIT - σ	
Series	**Product Category**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WE-TVS Standard	Voltage Regulator, < 1.5 W	50% 100%	**5.1** **5.2**	**A** **J**	**6.2** **6.2**	**k** **i**
WE-TVS High Speed						
WE-TVS Super Speed						
WE-TVSP						
WE-VE	Varistor, Metal Oxide	50% 100%	**5.2** **5.2**	**I** **H**	**6.2** **6.2**	**h** **g**
WE-VE ULC						
WE-VEA						
WE-VS						
WE-VD						

			FIT - λ		FIT - σ	
Series	**Product Category**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WE-CLFS, Single Stage	Line Filter (direct solder)	50%	**5.11**	**BO**	**6.11**	**bo**
		100%	**5.12**	**BU**	**6.12**	**bu**
	Line Filter (connector used)	50%	**5.13**	**CD**	**6.13**	**cd**
		100%	**5.13**	**CC**	**6.13**	**cc**
WE-CLFS, Single Stage, Low Leakage	Line Filter (direct solder)	50%	**5.11**	**BR**	**6.11**	**br**
		100%	**5.12**	**BW**	**6.12**	**bx**
	Line Filter (connector used)	50%	**5.13**	**CD**	**6.13**	**cd**
		100%	**5.13**	**CF**	**6.13**	**ce**
WE-CLFS, Single Stage Advanced	Line Filter (direct solder)	50%	**5.11**	**BN**	**6.11**	**bn**
		100%	**5.12**	**BT**	**6.12**	**bt**
	Line Filter (connector used)	50%	**5.13**	**CD**	**6.13**	**cd**
		100%	**5.13**	**CB**	**6.13**	**cb**
WE-CLFS, Single Stage Advanced, Low Leakage	Line Filter (direct solder)	50%	**5.11**	**BQ**	**6.11**	**bq**
		100%	**5.12**	**BV**	**6.12**	**bw**
	Line Filter (connector used)	50%	**5.13**	**CD**	**6.13**	**cd**
		100%	**5.13**	**CE**	**6.13**	**cc**
WE-CLFS, Two Stage	Line Filter (direct solder)	50%	**5.11**	**BM**	**6.11**	**bm**
		100%	**5.12**	**BS**	**6.12**	**bs**
	Line Filter (connector used)	50%	**5.13**	**CD**	**6.13**	**cd**
		100%	**5.13**	**CA**	**6.13**	**ca**
WE-CLFS, Two Stage, Low Leakage	Line Filter (direct solder)	50%	**5.11**	**BP**	**6.11**	**bp**
		100%	**5.12**	**BU**	**6.12**	**bv**
	Line Filter (connector used)	50%	**5.13**	**CD**	**6.13**	**cd**
		100%	**5.13**	**CC**	**6.13**	**cb**

4.2 Power Magnetics

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-CFWI					
WE-CHSA					
WE-CHSAP					
WE-DCT					
WE-DD					
WE-DPC					
WE-DPC HV					
WE-EHPI					
WE-FAMI					
WE-GF					
WE-GFH					
WE-HCC					
WE-HCF					
WE-HCFA					
WE-HCFT					
WE-HCI					
WE-HCIA	Coil, Load Coil	**5.1**	**A**	**6.1**	**b**
WE-HCIT					
WE-HCLW					
WE-HCM					
WE-HCRW					
WE-HIDA					
WE-LHCA					
WE-LHMD					
WE-LHMI					
WE-LQ					
WE-LQFS					
WE-LQS					
WE-LQS ECO					
WE-LQSH					
WE-MAIA					
WE-MAPI					
WE-MCRI					

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-MTCI					
WE-PD					
WE-PD HV					
WE-PD2					
WE-PDeco					
WE-PD2 HV					
WE-PD2A					
WE-PD2SA					
WE-PD2SR					
WE-PD2 HV					
WE-PD2A					
WE-PD2SA					
WE-PD2SR					
WE-PD3					
WE-PD4					
WE-PDA					
WE-PDF					
WE-PFC	Coil, Load Coil	**5.1**	**A**	**6.1**	**b**
WE-PMCI					
WE-PMI					
WE-PMMI					
WE-SI					
WE-SPC					
WE-TDC					
WE-TI					
WE-TI eco					
WE-TI HV					
WE-TIF					
WE-TIS					
WE-TPC					
WE-WPCC					
WE-XHMA					
WE-XHMI					
Custom Power Inductor					

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-CST	Transformer, Pulse Low Level	**5.2**	**J**	**6.2**	**j**
WE-GDT					
WE-GDTI					
WE-AGDT	Transformer, Power (> 1W)	**5.2**	**G**	**6.3**	**m**
WE-FB					
WE-FB3751					
WE-FLEX					
WE-FLEX+					
WE-FLEX HV					
WE-LLCR					
WE-PoE					
WE-PoE+					
WE-PoEH					
WE-PPTI					
WE-Unit					
WE-UOST					
Custom Power					

4.3 Signal & Communication

			FIT - λ		FIT - σ	
Series	**Product Category**		**Graph**	**Curve**	**Graph**	**Curve**
WE-ASI	Coil, Load Coil		**5.1**	**A**	**6.1**	**b**
WE-BAL **WE-BPF** **WE-CCMF** **WE-KI** **WE-KI HC** **WE-LPF** **WE-MCA** **WE-MCI** **WE-MK** **WE-RFH** **WE-RFI** **WE-TCI**	Coil, Chip/Ceramic Filter		**5.1**	**C**	**6.1**	**d**
WE-CAIR **WE-ACHC**	Coil, Radio Frequency, Fixed		**5.1**	**C**	**6.1**	**f**
WE-BMS **WE-LAN** **WE-LAN AQ** **WE-LAN 10G** **Custom LAN**	Transformer, Radio Frequency		**5.3**	**Q**	**6.3**	**p**
WE-RJ45 LAN	Transformer, Radio Frequency, with RJ45 Connector	**1-port**	**5.3**	**O**	**6.5**	**ac**
WE-RJ45 LAN TH Reflow		**2-ports**	**5.3**	**N**	**6.5**	**ab**
WE-RJ45LAN 10G		**4-ports**	**5.3**	**M**	**6.5**	**aa**
WE-LANMX	Transformer, Radio Frequency with M12 Connector		**5.3**	**P**	**6.3**	**o**
WE-STST **Custom Signal**	Transformer, Pulse Low Level		**5.2**	**J**	**6.2**	**j**

4.4 Opto-Electronic Parts

It takes many years' worth of detailed field data for a large number of parts to make conclusions about the failure rates of products. For this reason, many companies, including Würth Elektronik, rely on the published standards which make predictions about the reliability of product types. The values given in this section are estimations based solely on Telcordia's SR-332 standard, as a measure of the random failures during the normal, useful life of the product. However, additional consideration should be given to the application and environment conditions of the LED, including current and voltage, junction temperature, humidity, duty cycle and UV exposure. In-depth reliability testing tailored to the end application and environment is likely to yield better indications of the general reliability of LEDs.

It should also be noted, that the intent of the system FIT rate calculation should be considered with respect to LEDs. An LED might stop emitting light, but still function as a diode, and therefore does not cause a breakdown of the system. If the system FIT determination is estimating the service availability rather than rates of return, then LEDs may be excluded from the system calculation.

With respect to optocouplers, additional information regarding lifetime can be found in our app note ANO006. For a distinction between FIT rate and lifetime, please see the FAQ section of this FIT document.

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WL-SBCD	Single LED	**5.4**	**T**	**6.4**	**t**
WL-SBCW					
WL-SBRW					
WL-SBSW					
WL-SBTW					
WL-SFCC					
WL-SFCD					
WL-SFCW					
WL-SFRW					
WL-SFSW					
WL-SFTD					
WL-SFTW					
WL-SICW					
WL-SIMW					
WL-SIQW					
WL-SIRW					
WL-SISW					
WL-SITW					
WL-SMCC					
WL-SMCD					

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WL-SMCW	Single LED	**5.4**	**T**	**6.4**	**t**
WL-SMDC					
WL-SMRW					
WL-SMSW					
WL-SMTD					
WL-SMTW					
WL-SUMW					
WL-SWTC					
WL-SWTP					
WL-TIRC					
WL-TIRW					
WL-TMRC					
WL-TMRW					
WL-VCSL					
WL-S7DS	LED	**5.4**	**S**	**6.4**	**s**
WL-T7DS					
WL-STCB	Phototransistor	**5.10**	**BG**	**6.10**	**bg**
WL-STCW					
WL-STRB					
WL-STSB					
WL-STSW					
WL-STTB					
WL-STTW					
WL-TTRB					
WL-TTRW					
WL-SDCB	Photodiode	**5.10**	**BH**	**6.10**	**bh**
WL-SDSB					
WL-TDRW					
WL-TDRB					
WL-OCPT	Optocoupler	**5.4**	**U**	**6.4**	**u**
WL-OCDA					

4.5 Capacitors

			FIT - λ		FIT - σ	
Series	**Product Category**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WCAP-FTBE	Fixed, Plastic	30%	**5.5**	**AD**	**6.1**	**e**
WCAP-FTBP		50%	**5.5**	**AC**	**6.1**	**c**
WCAP-FTX2		70%	**5.5**	**AB**	**6.1**	**a**
WCAP-FTXX		100%	**5.5**	**AA**	**6.3**	**n**
WCAP-AI3H	Fixed, Aluminum, Electrolytic, Fixed, < 400 µF	30%	**5.6**	**AJ**	**6.6**	**aj**
WCAP-AIE8		50%	**5.6**	**AI**	**6.6**	**ai**
WCAP-AIG5		70%	**5.6**	**AH**	**6.6**	**ah**
WCAP-AIG8		100%	**5.6**	**AG**	**6.6**	**ag**
WCAP-AIL5						
WCAP-AIL8						
WCAP-AS5H						
WCAP-ASLI						
WCAP-ASLL						
WCAP-ASLU						
WCAP-ASNP						
WCAP-AT1H						
WCAP-ATET						
WCAP-ATG5						
WCAP-ATG8						
WCAP-ATLI						
WCAP-ATLL						
WCAP-ATUL						
WCAP-PHET						
WCAP-PHGP						
WCAP-PHLE						
WCAP-PHSE						
WCAP-PSHP						
WCAP-PSLC						
WCAP-PSLP						
WCAP-PTG5						
WCAP-PTHR						
WCAP-PTHT						
WCAP-PT5H						

			FIT - λ		FIT - σ	
Series	**Product Category**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WCAP-AI3H	Fixed, Aluminum, Electrolytic, Fixed, > 400 µF	30% 50% 70% 100%	**5.9** **5.9** **5.9** **5.9**	**BD** **BC** **BB** **BA**	**6.9** **6.9** **6.9** **6.9**	**bd** **bc** **bb** **ba**
WCAP-AIE8						
WCAP-AIG5						
WCAP-AIG8						
WCAP-AIL5						
WCAP-AIL8						
WCAP-AS5H						
WCAP-ASLI						
WCAP-ASLL						
WCAP-ASNP						
WCAP-AT1H						
WCAP-ATET						
WCAP-ATG5						
WCAP-ATG8						
WCAP-ATLI						
WCAP-ATLL						
WCAP-ATUL						
WCAP-PHGP						
WCAP-PHLE						
WCAP-PHSE						
WCAP-PSHP						
WCAP-PSLC						
WCAP-PTG5						
WCAP-PTHT						
WCAP-PT5H						
WCAP-CSGP	Fixed, Ceramic	30% 50% 70% 100%	**5.7** **5.7** **5.7** **5.7**	**AP** **AO** **AN** **AM**	**6.7** **6.7** **6.7** **6.7**	**ap** **ao** **an** **am**
WCAP-CSMH						
WCAP-CSRF						
WCAP-CSSA						
WCAP-CSST						
WCAP-STSC	Unlisted					

4.6 Frequency Products

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-XTAL	Quartz Crystal	**5.8**	**AT**	**6.8**	**at**
WE-SPXO	Crystal Oscillator, Quartz Controlled	**5.8**	**AS**	**6.8**	**as**

4.7 Resistance

			FIT - λ		FIT - σ	
Series	**Product Category**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WRIS-KSKE	Fixed, Film (Carbon, Oxide, Metal), ≤1 Megohm	50%	**5.16**	**CT**	**6.16**	**ct**
WRIS-KWKB		100%	**5.16**	**CS**	**6.16**	**cs**
WRIS-KWKH						
WRIS-PSMB	Fixed, Composition, ≤1 Megohm	50%	**5.17**	**DB**	**6.17**	**db**
WRIS-PSMC		100%	**5.17**	**DA**	**6.17**	**da**
WRIS-PWMC						

4.8 Connectors

It takes many years' worth of detailed field data for a large number of parts to make conclusions about the failure rates of products. For this reason, many companies, including Würth Elektronik, rely on the published standards which make predictions about the reliability of product types. While the Telcordia standard provides data for FIT rates of connectors, the standard does not consider or define many significant factors which affect reliability of plug-in type and terminal block connectors, including:

- The conditions of the environment, including vibration, shock, contamination and humidity.
- The number of insertions that a connector undergoes. In general, connectors wear out as they are connected and disconnected over and over.
- Material plating of contacts. Material plating has a large influence on reliability, but different material platings are not differentiated in the Telcordia standard.
- The definition of failure is very subjective with connectors. Often, a poor connection still conducts a signal or current, but not to the extent of its original capabilities. The failure rate is directly influenced by how a failure is defined.

Due to the broad spectrum of influencing factors and the environments in which connectors are used, failure rates for connectors cannot be generalized or summarized into a single value while maintaining confidence in the predicted value. For this reason, most of our connectors are not included in this document. Rather, it is encouraged to refer to well-detailed reliability test reports to make determinations about the suitability of connectors for your application.

Wire, cable, solder connections, wire wrap connections and printed wiring boards may be excluded from the unit failure rates, as these correlate to workmanship and control of manufacturing processes.

Failures of connectors are counted as one failure per *mated pair*. Therefore, the FIT rates given below should be counted only once per *mated pair*.

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WP-BUCF	General Purpose, Power ***See Press Fit note below*	**5.15**	**CM**	**6.15**	**cm**
WP-BUFU					
WP-BUTR					
WP-RAFU					
WP-RATR					
WP-SHFU					
WP-TGCF					
WP-TGTR					
WP-TPSE					
WP-SMBU	General Purpose, Power	**5.15**	**CM**	**6.15**	**cm**
WP-SMSH					
WP-SMRT					
WP-THRBU					
WP-THRSH					

** Regarding Press-Fit board connections: The Telcordia standard excludes solder connections from failure rate predictions, as it is assumed that manufacturers control their manufacturing processes which results in negligible contribution to unit failure rates. Although the board connection is excluded from the FIT rate, evidence indicates that the Press-Fit technology is superior to standard SMT and TH solder connections.

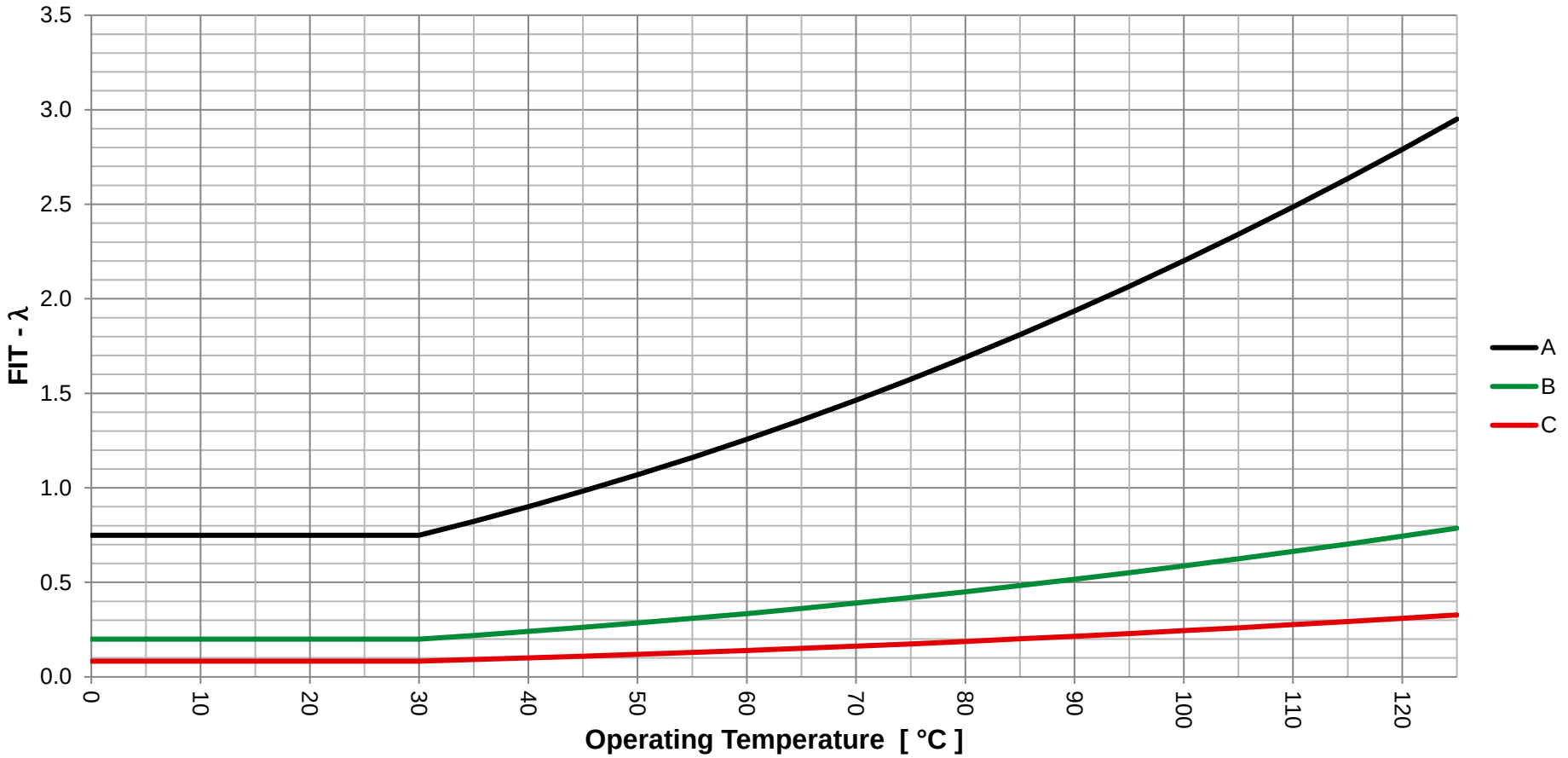
4.9 MagI³C Power Modules

The FIT rates for the MagI³C Power Modules are provided in accordance with MIL-HDBK-217F and supported by reliability testing. These rates are typical values at 60% UCL. (Unless otherwise noted, the FIT rates for all other products in this document are based on the calculation models of Telcordia SR-332.)

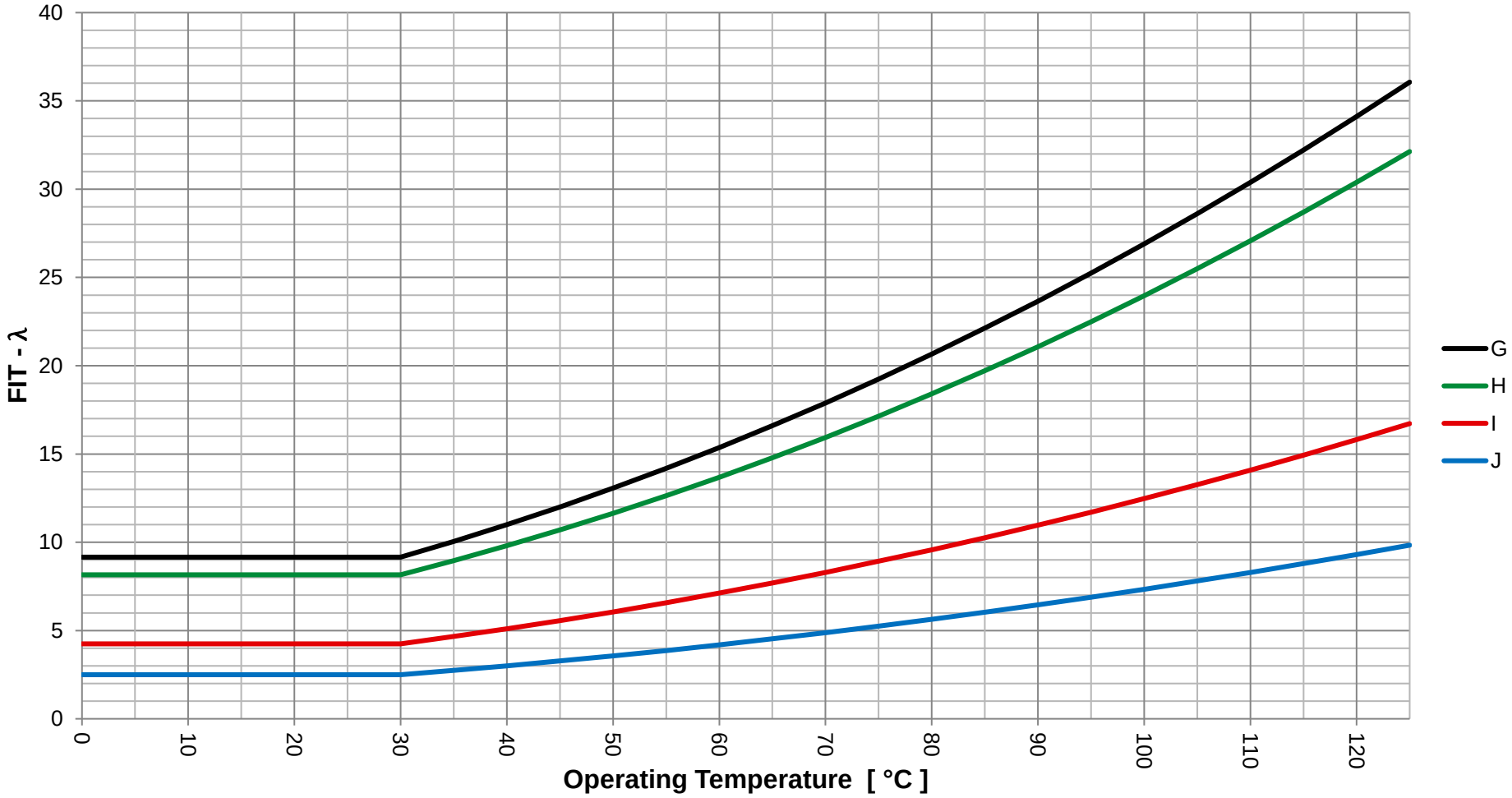
		FIT - λ	
Series	**Size / Order Code**	**Condition**	**Value**
MagI³C-FDSM	SIP-3 / 17395*xx*36 or 17301*xx*35	**25 °C**	**500**
	SIP-3 / 173010*x*42	**25 °C** **70 °C**	**116** **296**
	SIP-3 / 173950*x*78 or 173010*x*78	**25 °C** **70 °C**	**239** **458**
MagI³C-FISM	SIP-4 / 1779205*x*1	**25 °C** **85 °C**	**44.7** **108**
	SIP-7 / 1779205*x*4	**25 °C** **85 °C**	**75.8** **192**
	SMT-8 / 1769205*x*2 or 1768*x*1*x*12	**25 °C** **100 °C**	**333** **1053**
MagI³C-LDHM	TO263-7EP / 172946001	**55 °C**	**1.81**
MagI³C-VDMM	LGA-6EP / 1710105*xx*	**70 °C**	**23.8**
	LGA-6EP / 171960501	**100 °C**	**471**
	LGA-8EP / 171930601	**85 °C**	**7.69**
MagI³C-VDRM	BQFN-39 / 1710*x*0302	**55 °C**	**0.100**
	BQFN-41 / 171021501	**55 °C**	**0.559**
	LGA-16EP / 1710*x*1801	**55 °C**	**0.029**
	TO263-7EP / 1710*x*0601 (*x* = 1, 2 or 3)	**55 °C**	**1.81**
	TO263-7EP / 1710*x*0601 (*x* = 5)	**55 °C**	**28.9**
	TO263-7EP / 17101240*x*	**55 °C**	**1.81**
	TO263-7EP / 171032401	**55 °C**	**1.83**
MagI³C-VISM	SIP-8 / 17791063215	**55 °C**	**2.54**

5 λ Graphs

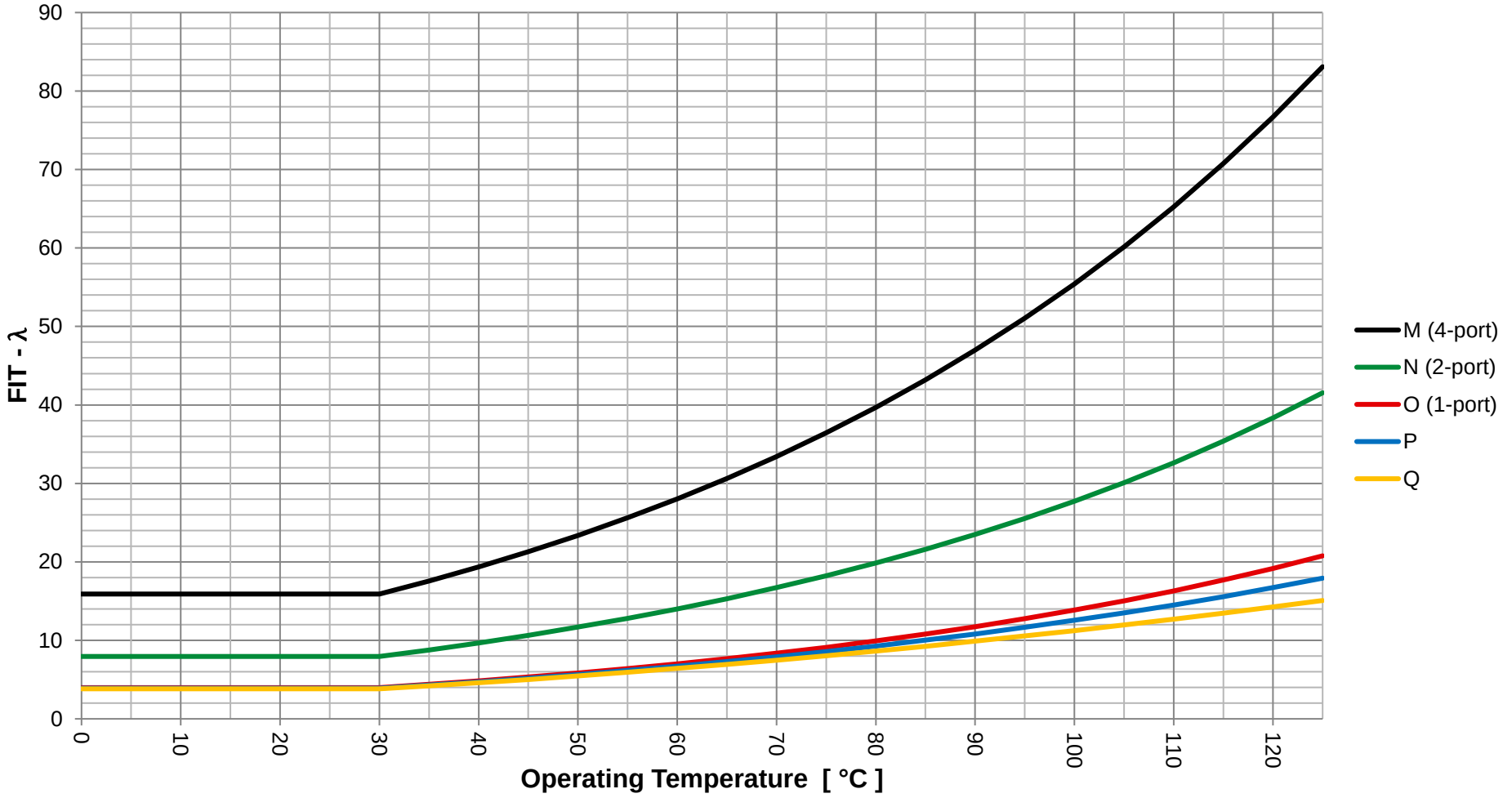
5.1 Graph λ-Values



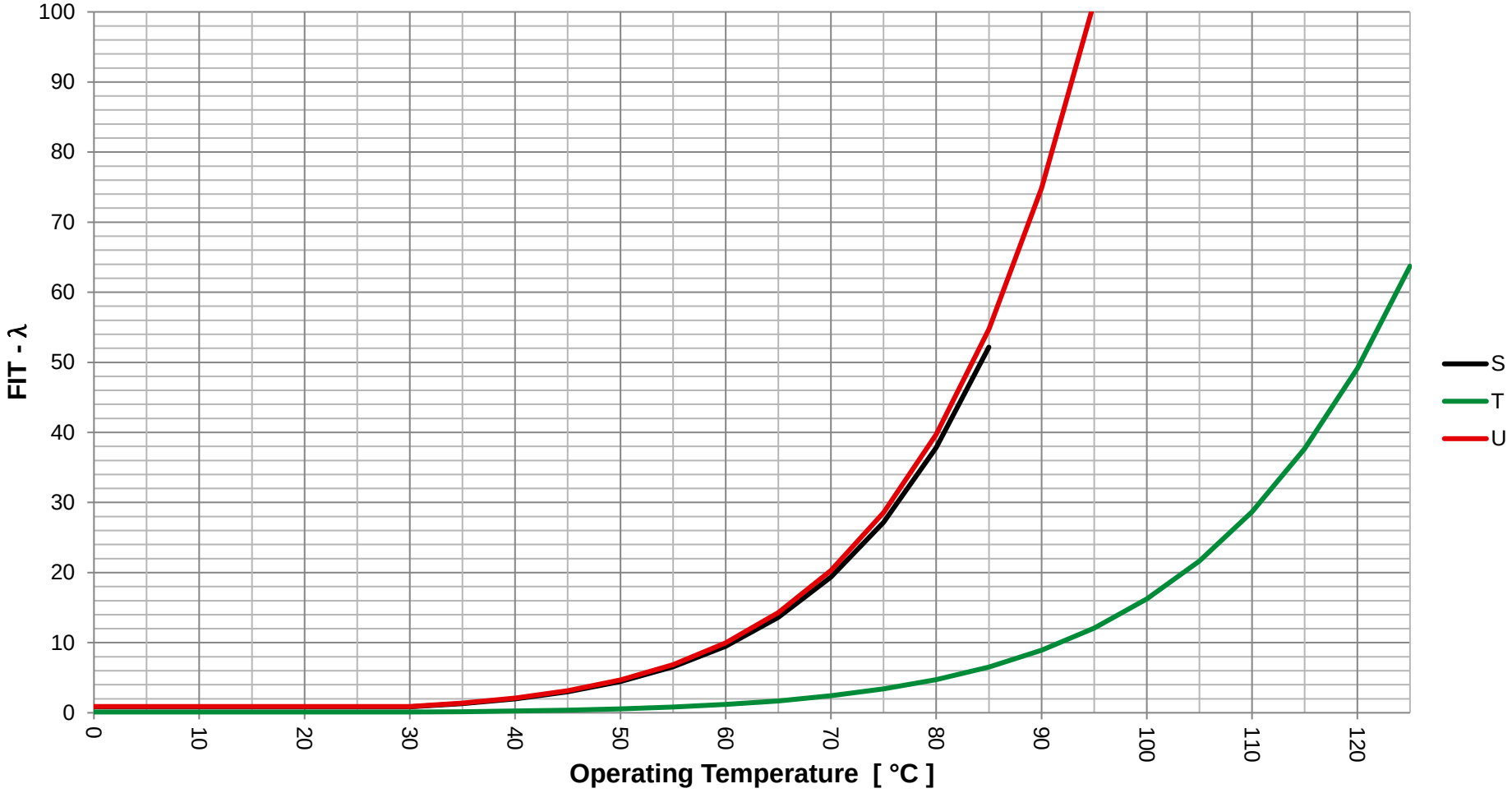
5.2 Graph λ-Values



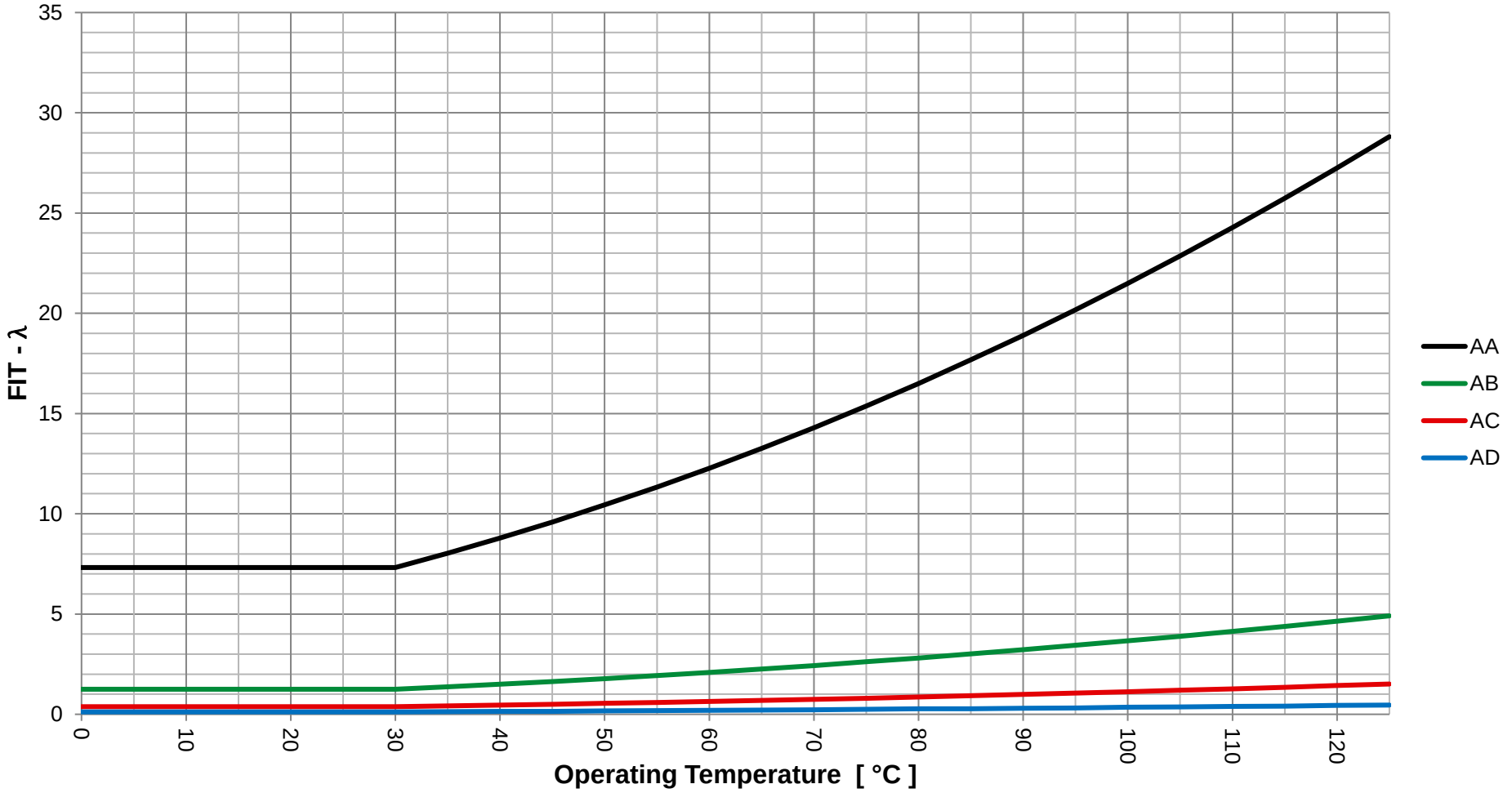
5.3 Graph λ-Values



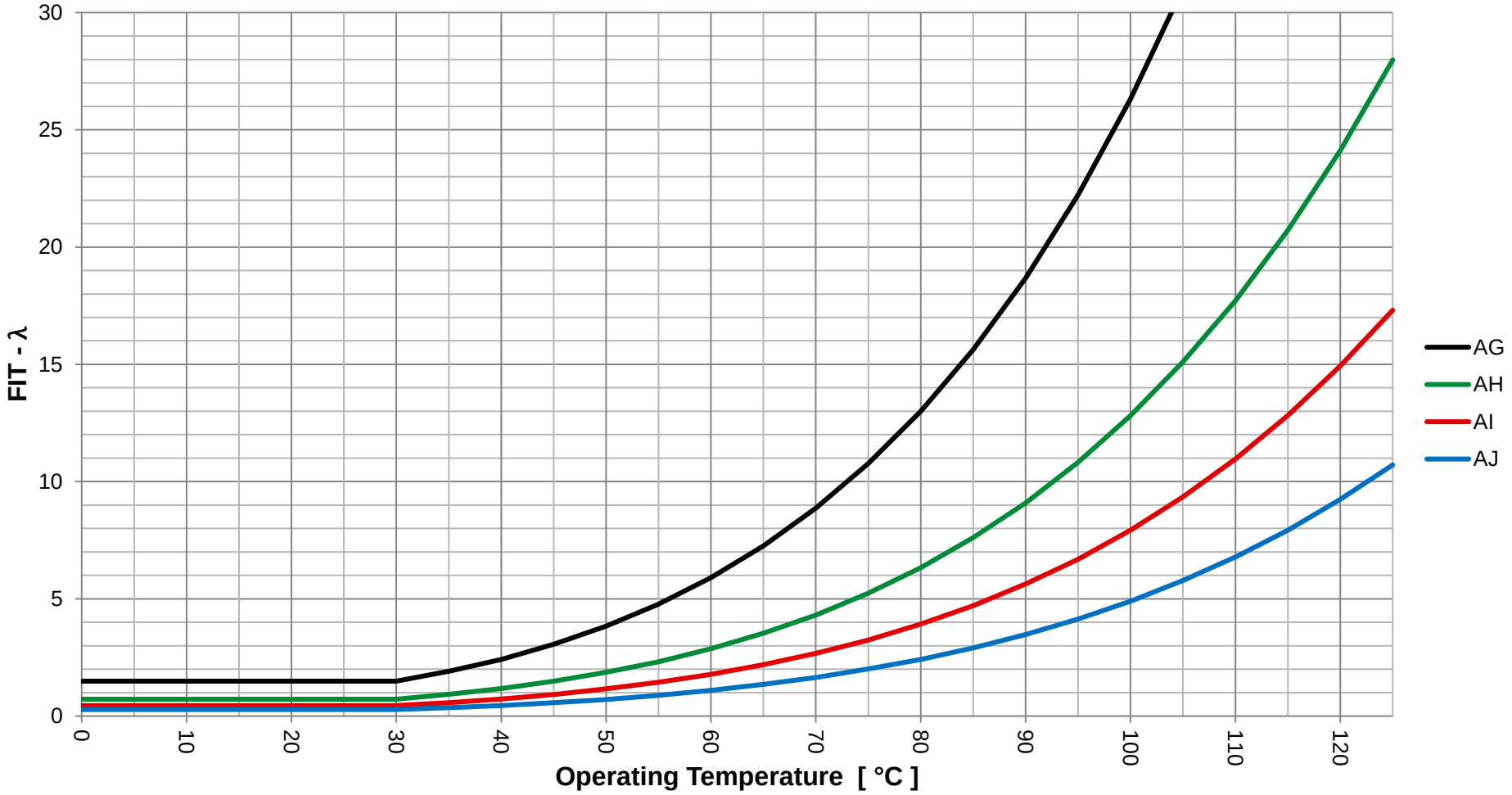
5.4 Graph λ-Values



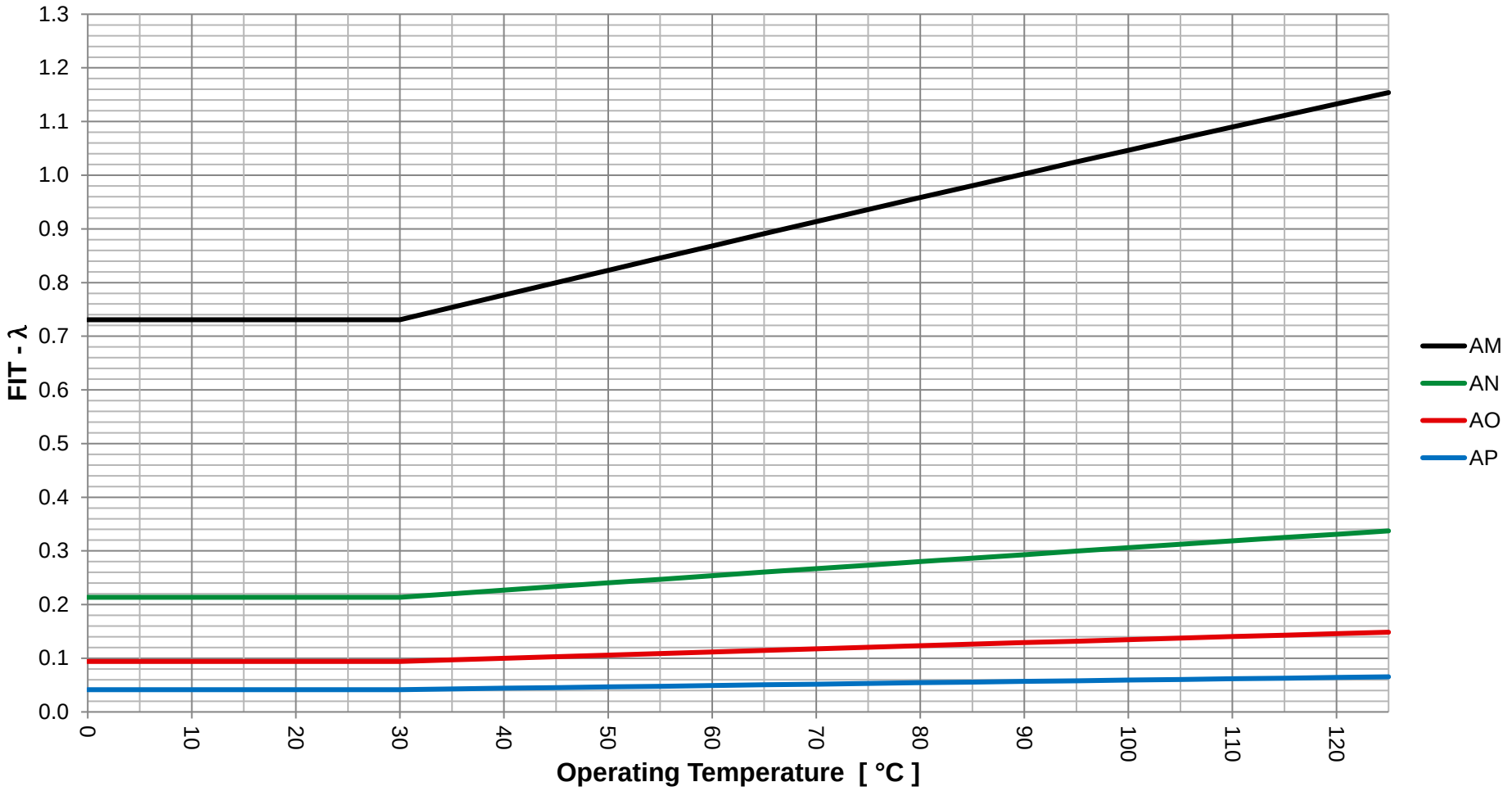
5.5 Graph λ-Values



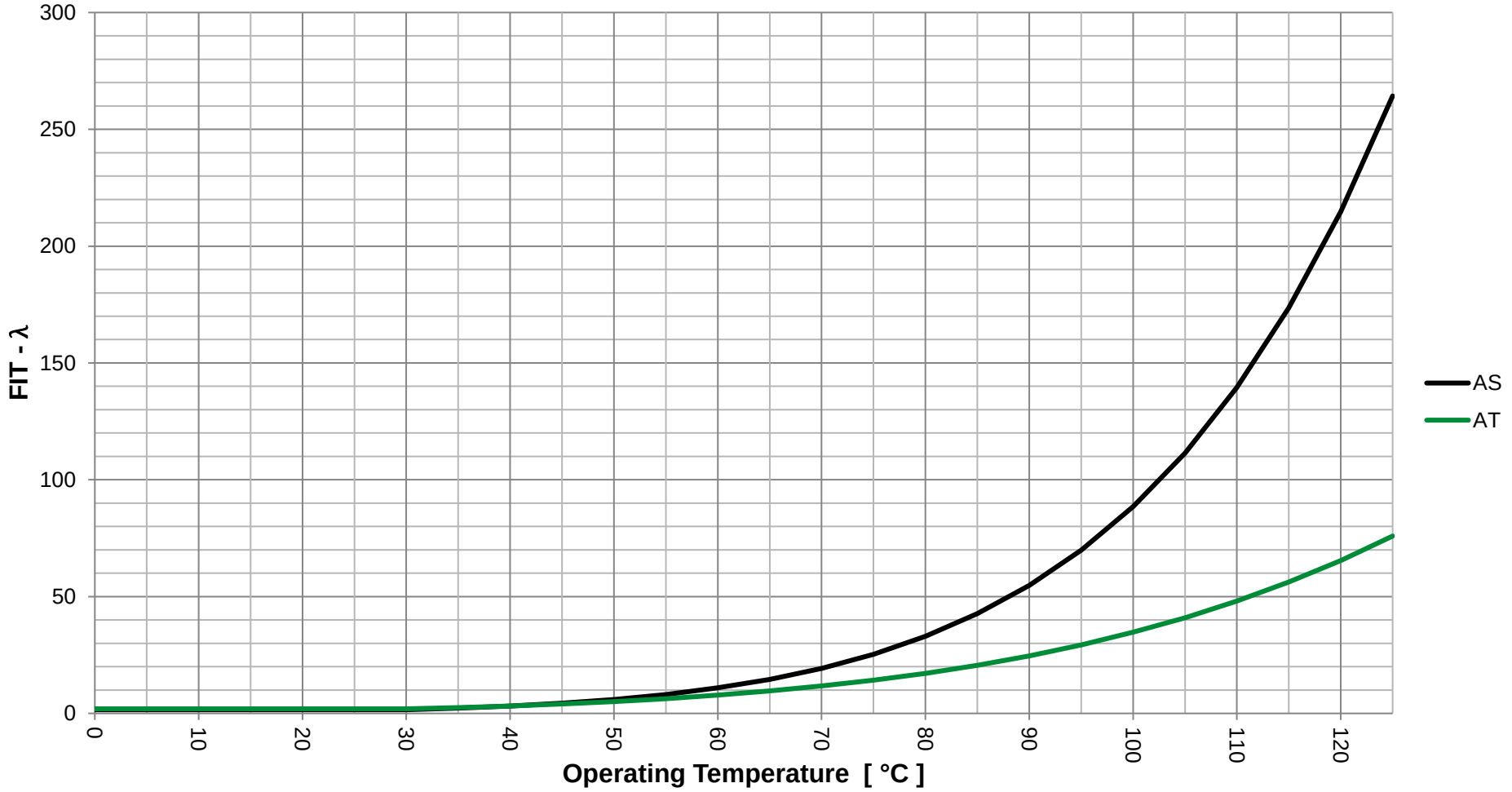
5.6 Graph λ-Values



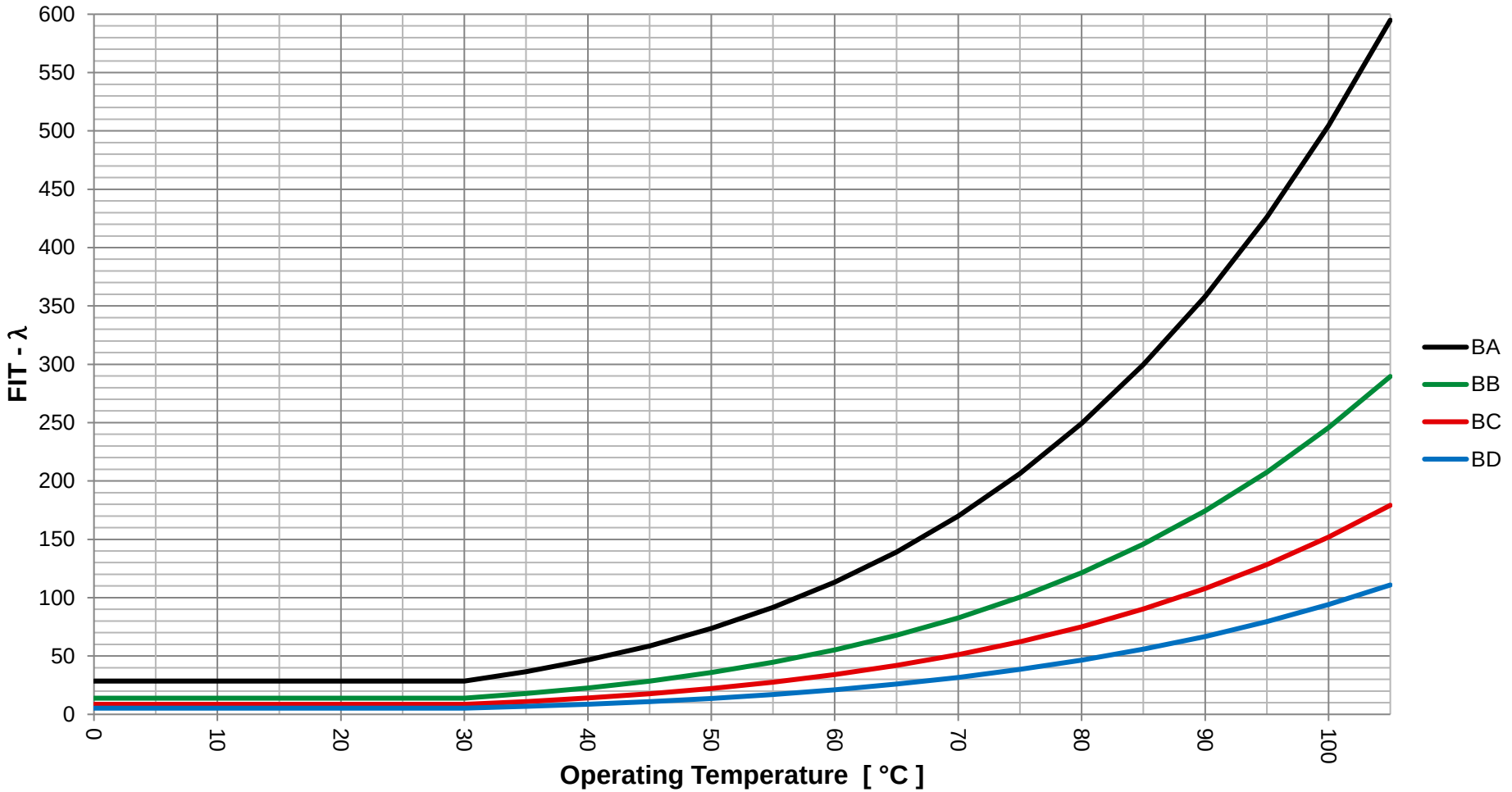
5.7 Graph λ-Values



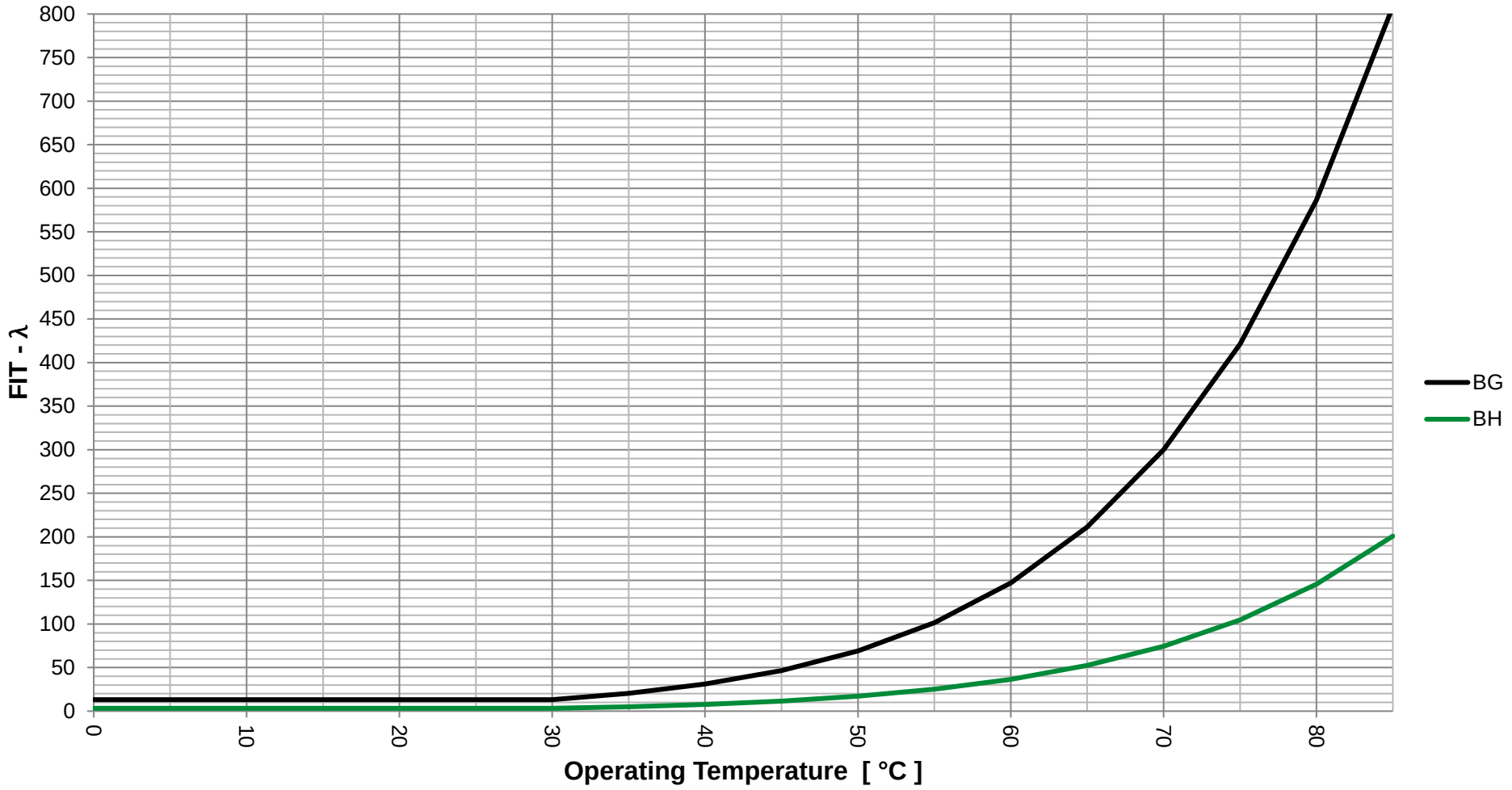
5.8 Graph λ-Values



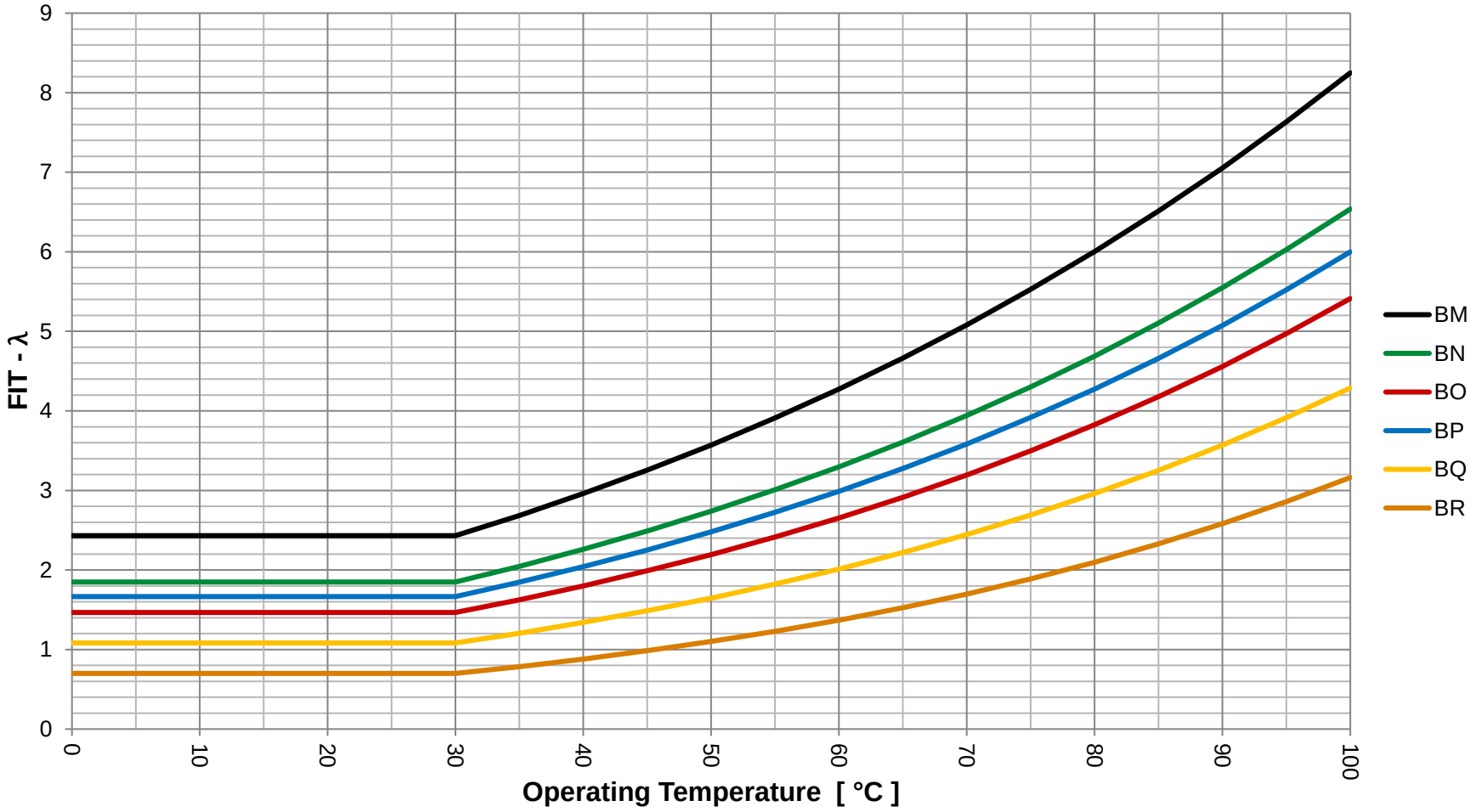
5.9 Graph λ-Values



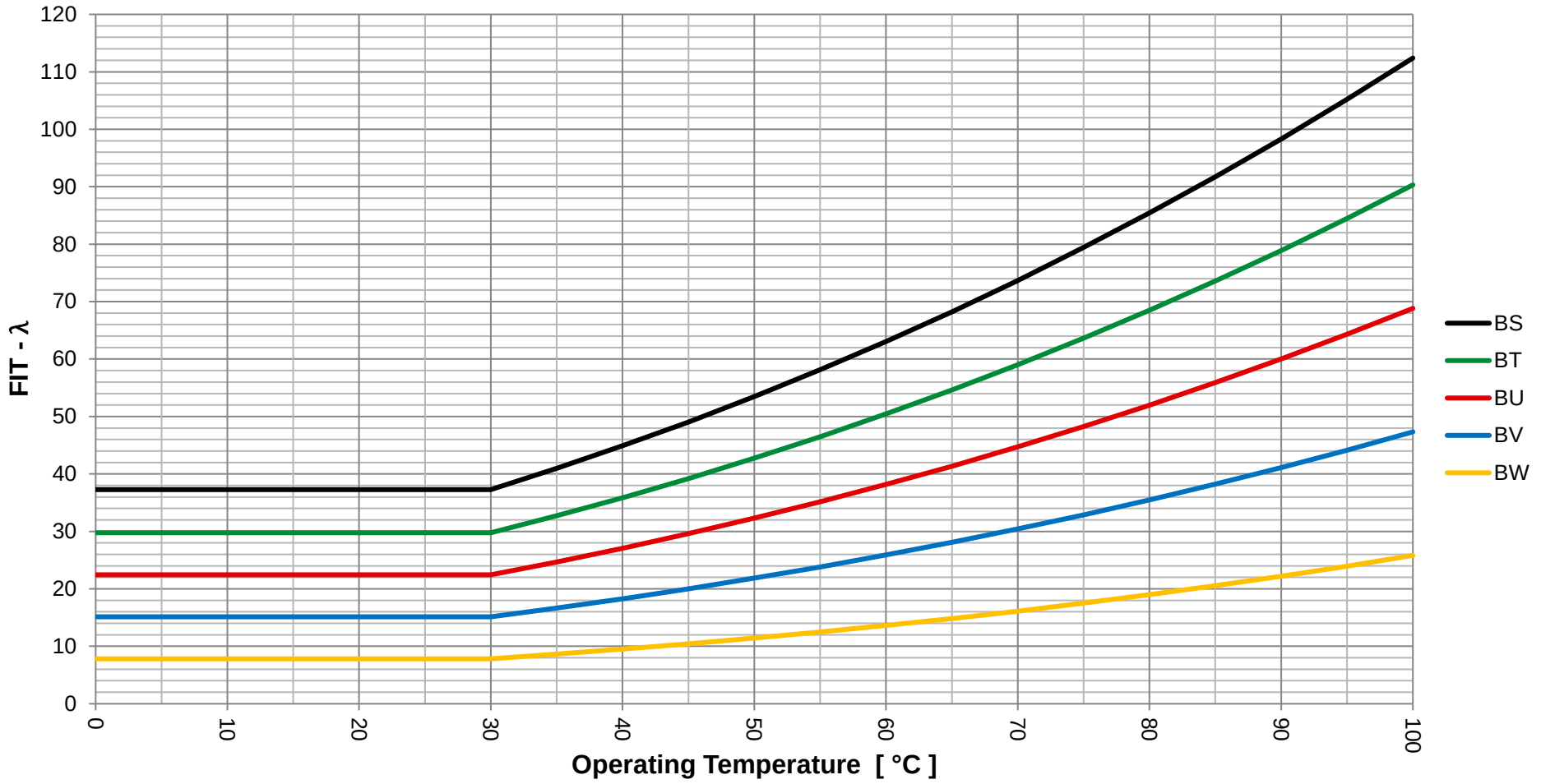
5.10 Graph λ-Values



5.11 Graph λ-Values

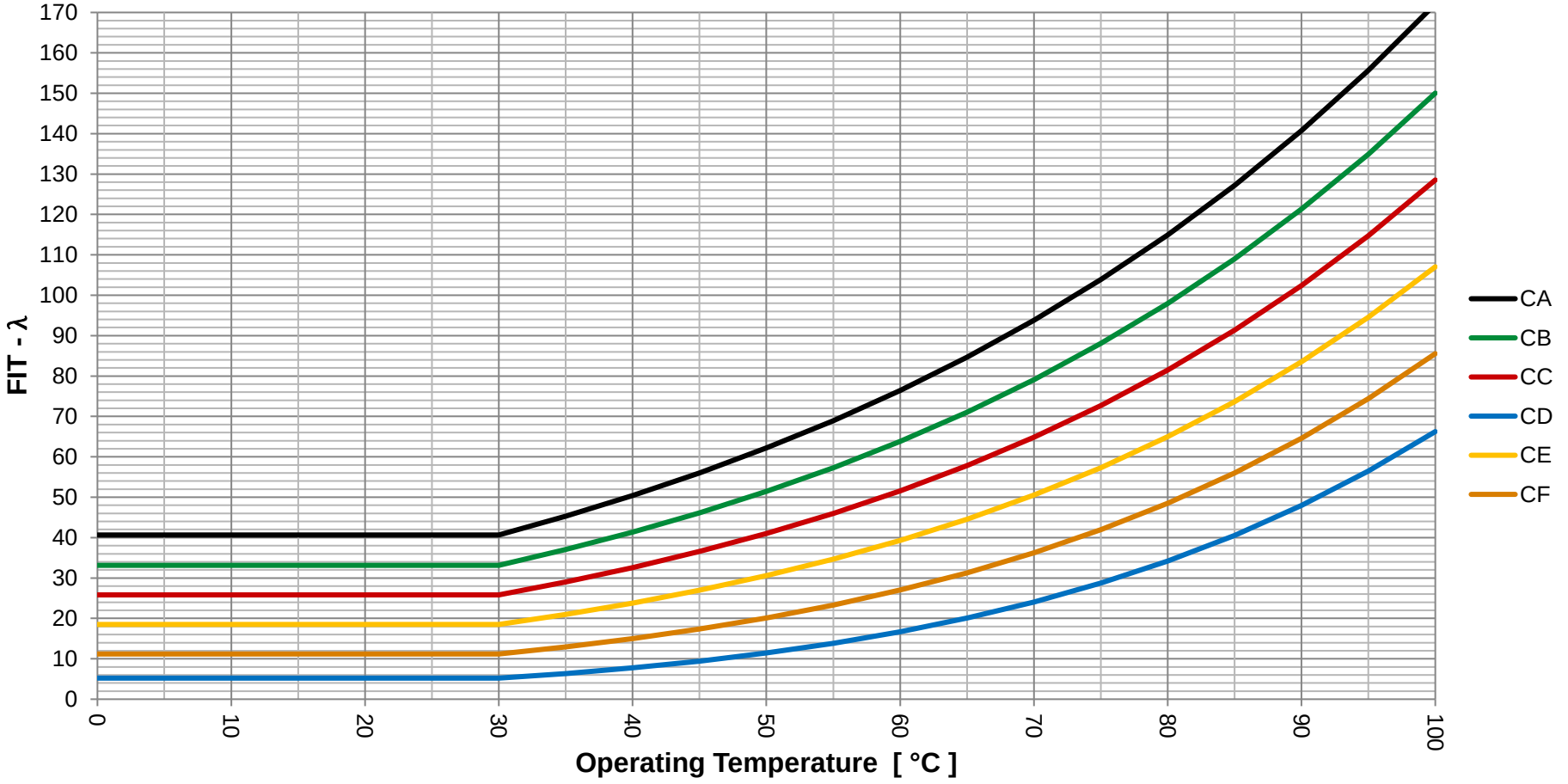


5.12 Graph λ-Values



5.13 Graph λ-Values

Failures of connectors are counted as one failure per mated *pair*. The FIT rate of WE-CLFS using connectors considers the terminals as 50% of the mated connection pair. The failure rate of the female connectors that are mated to the terminals in this component should be counted at 50%.



5.14 Graph λ-Values

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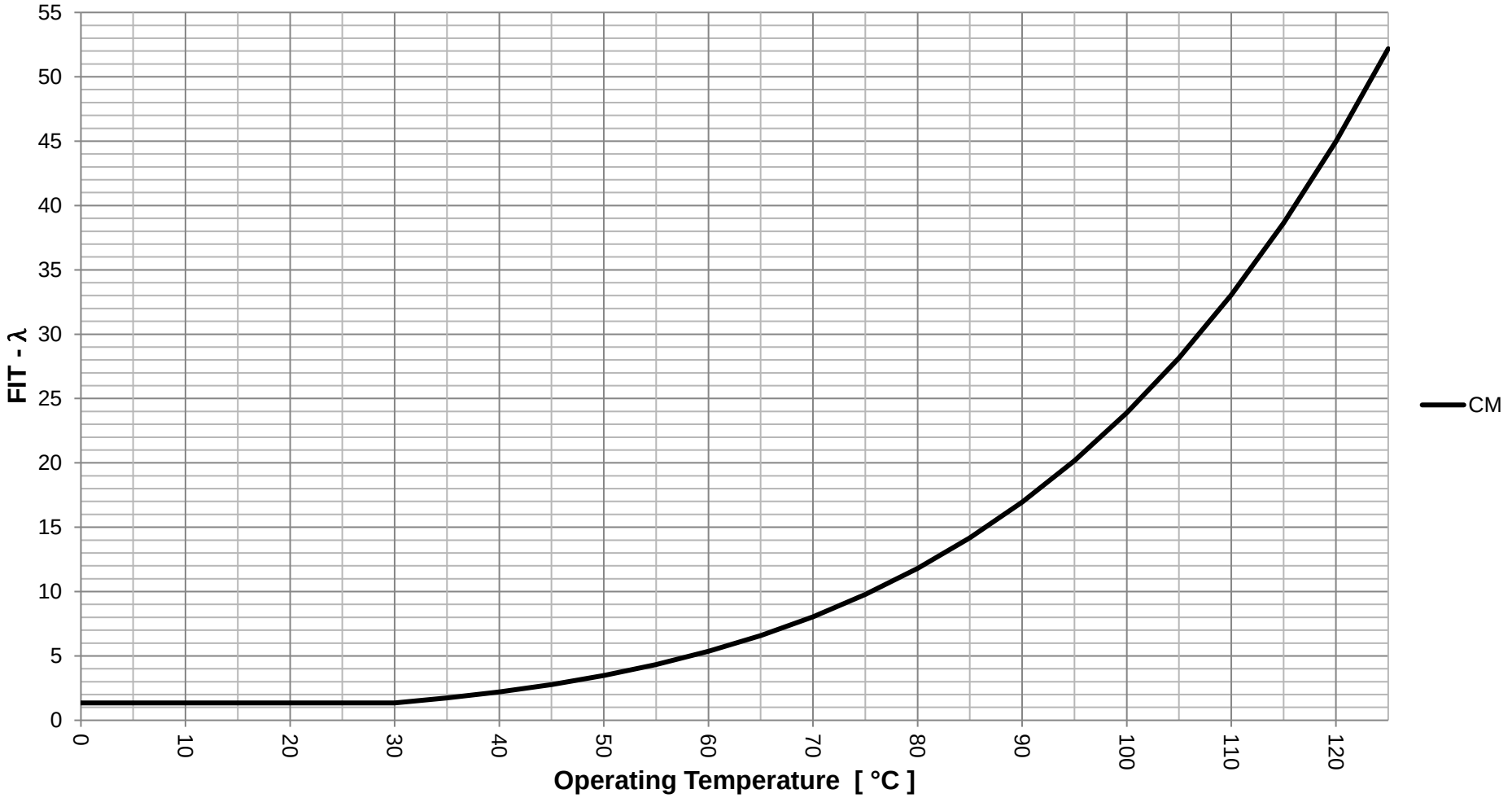
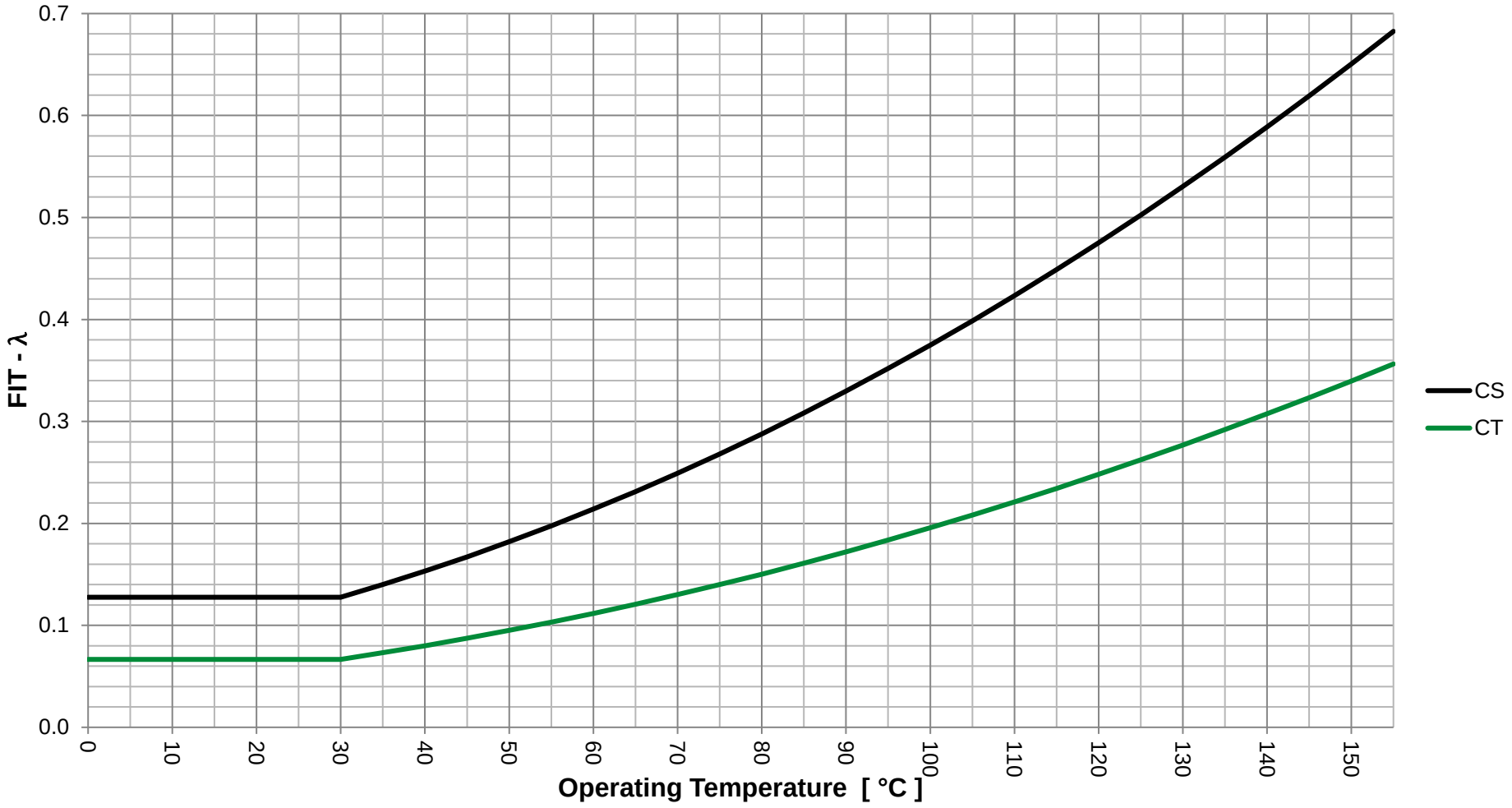
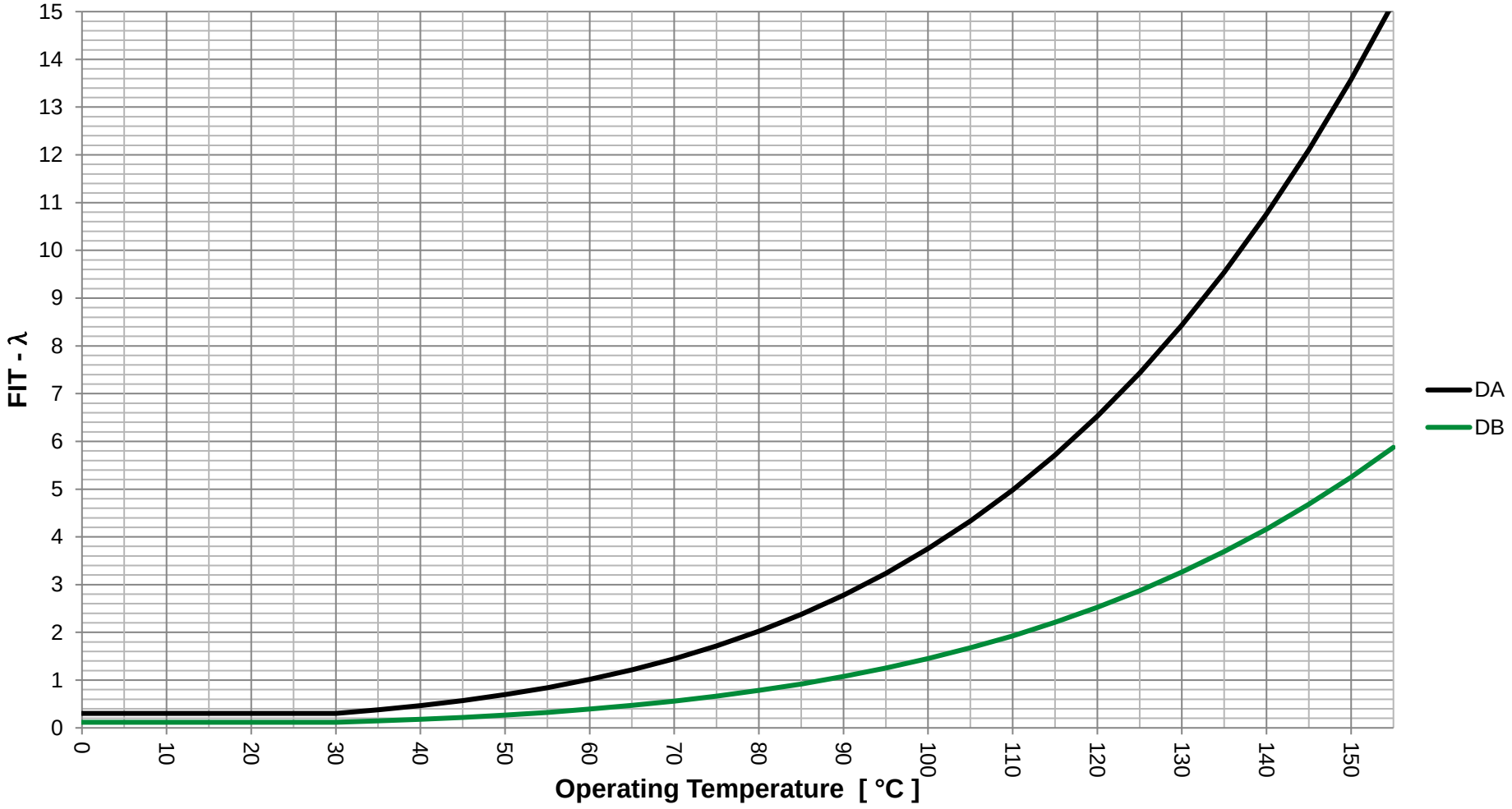
5.15 Graph λ-Values



5.16 Graph λ-Values

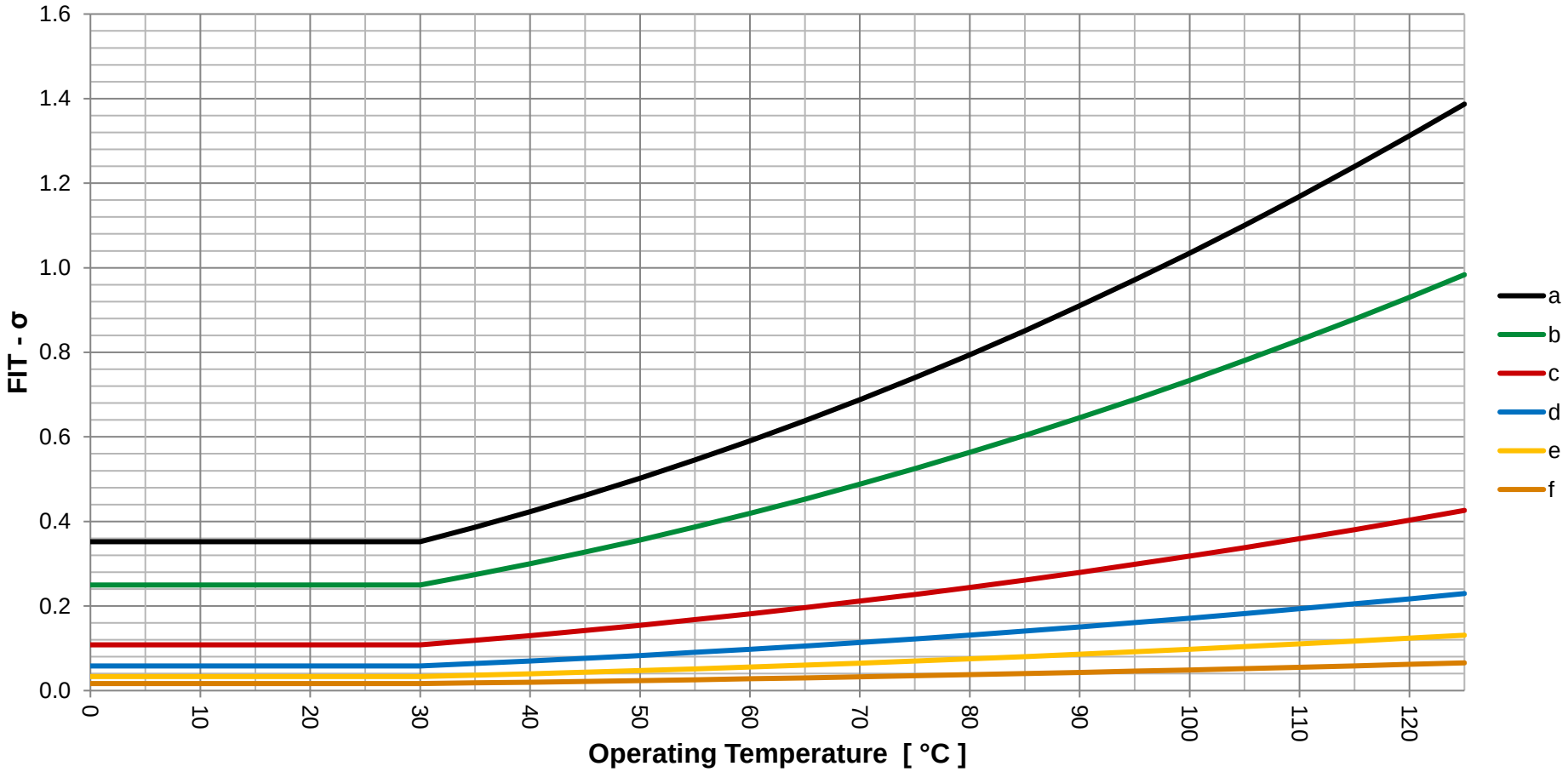


5.17 Graph λ-Values

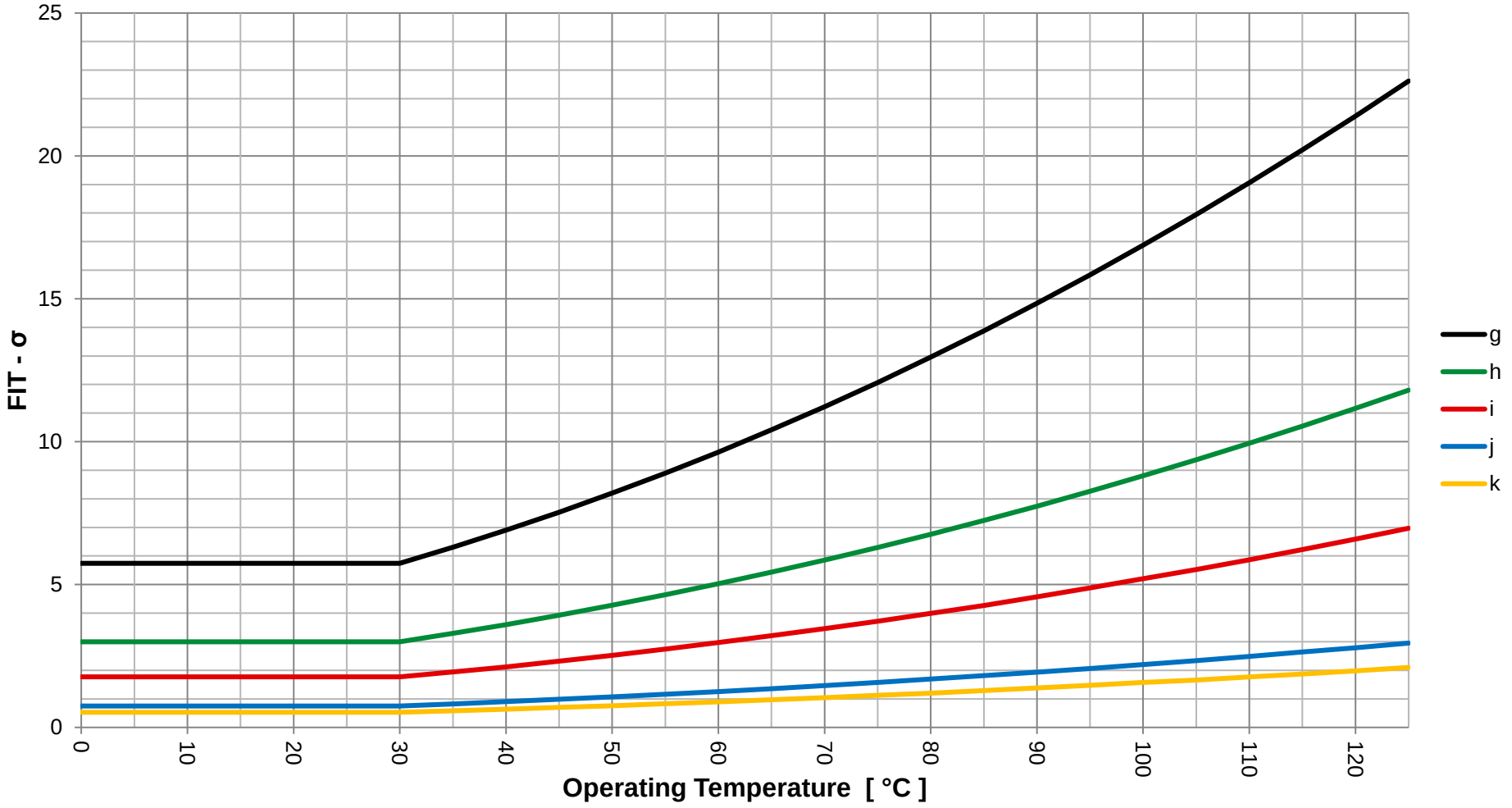


6 σ Graphs

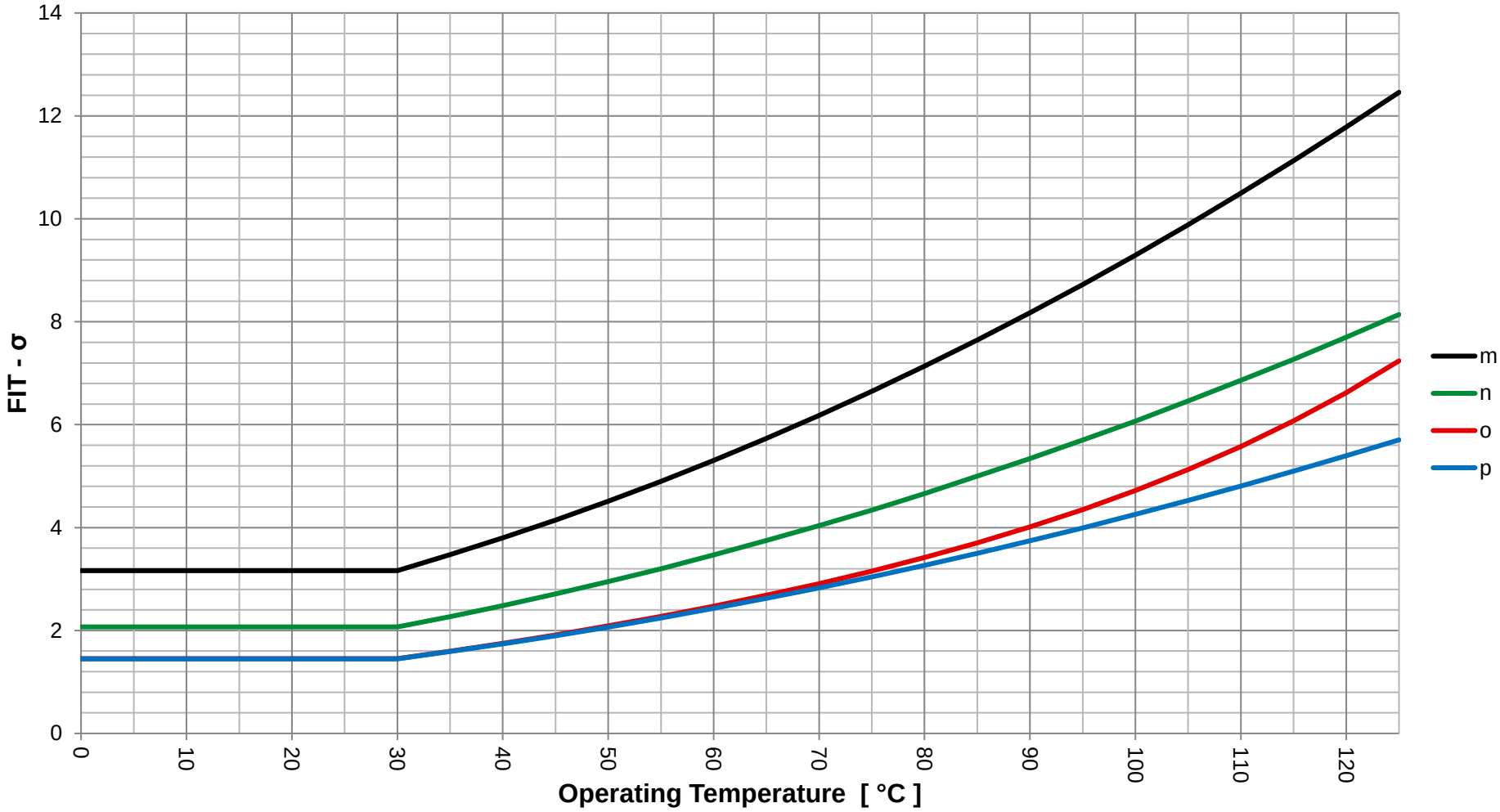
6.1 Graph σ-Values



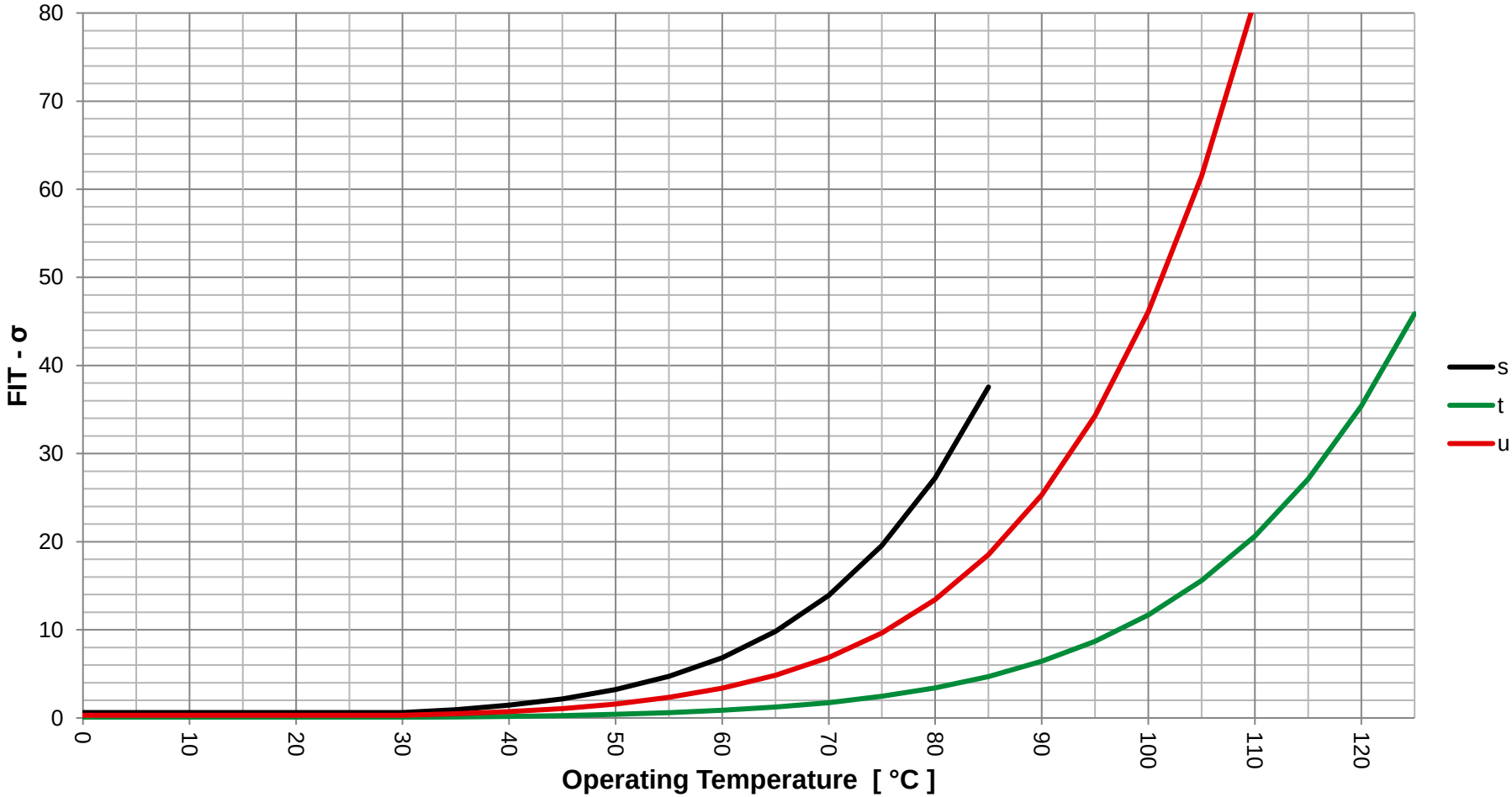
6.2 Graph σ-Values



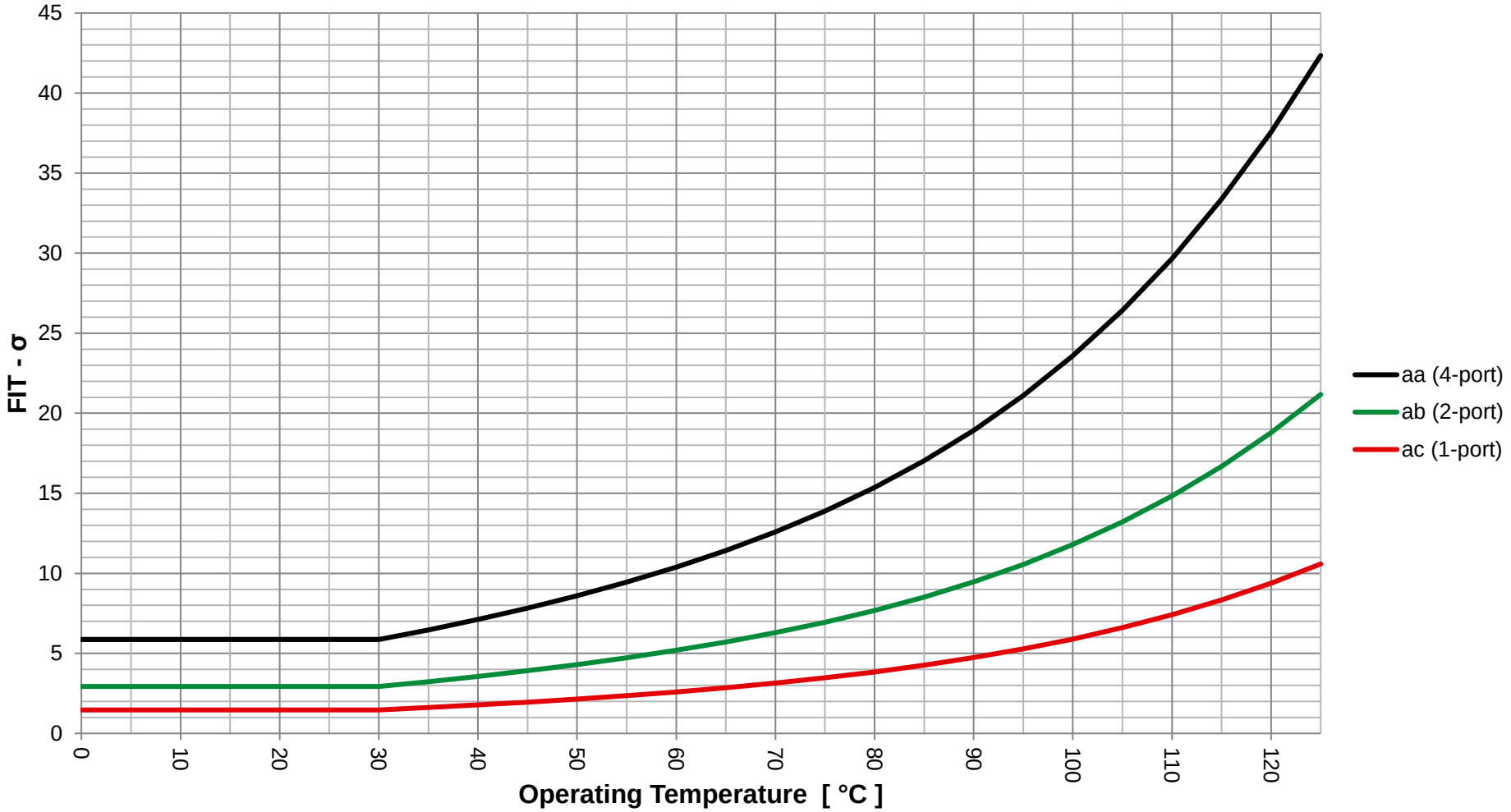
6.3 Graph σ-Values



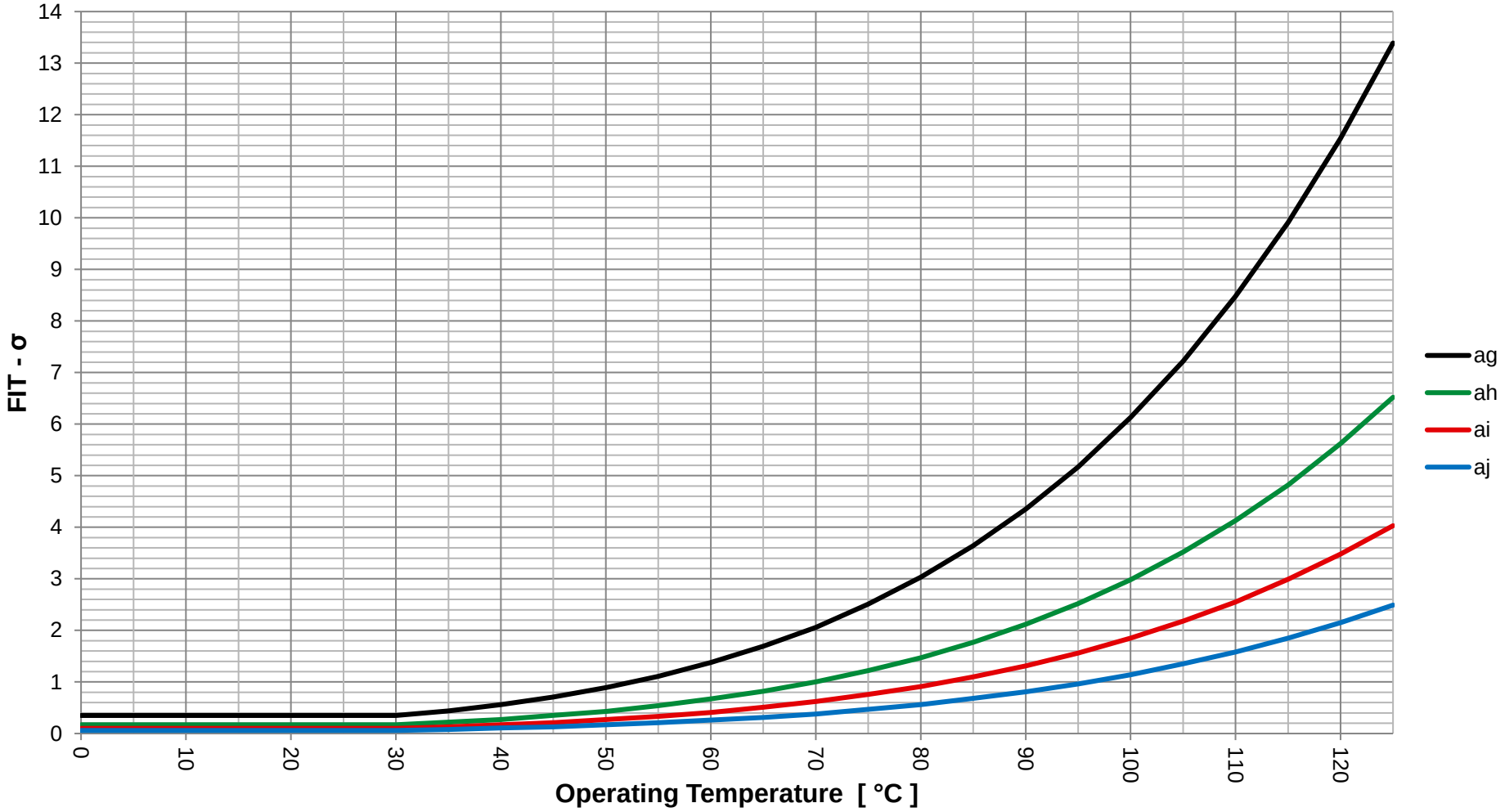
6.4 Graph σ-Values



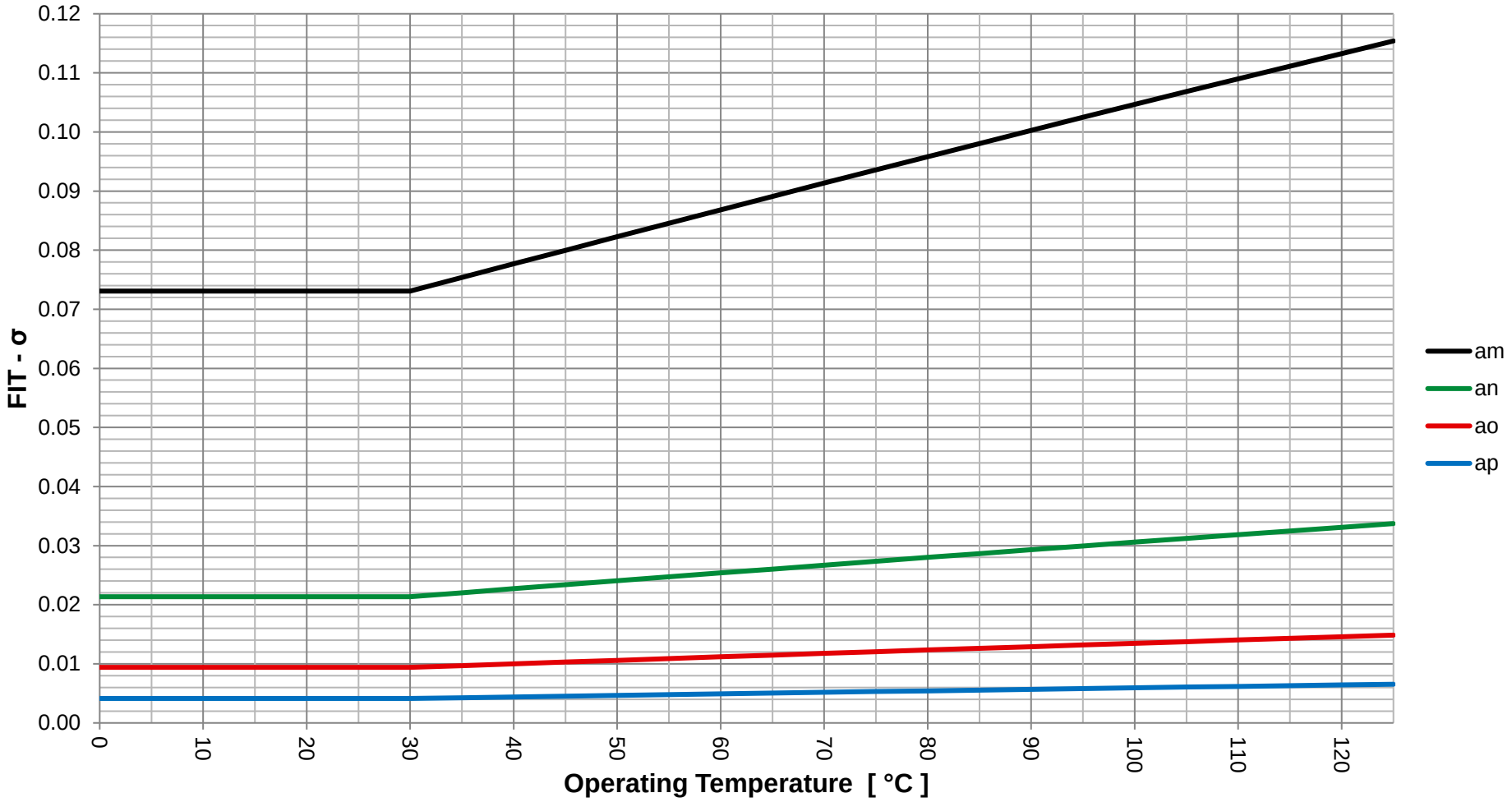
6.5 Graph σ-Values



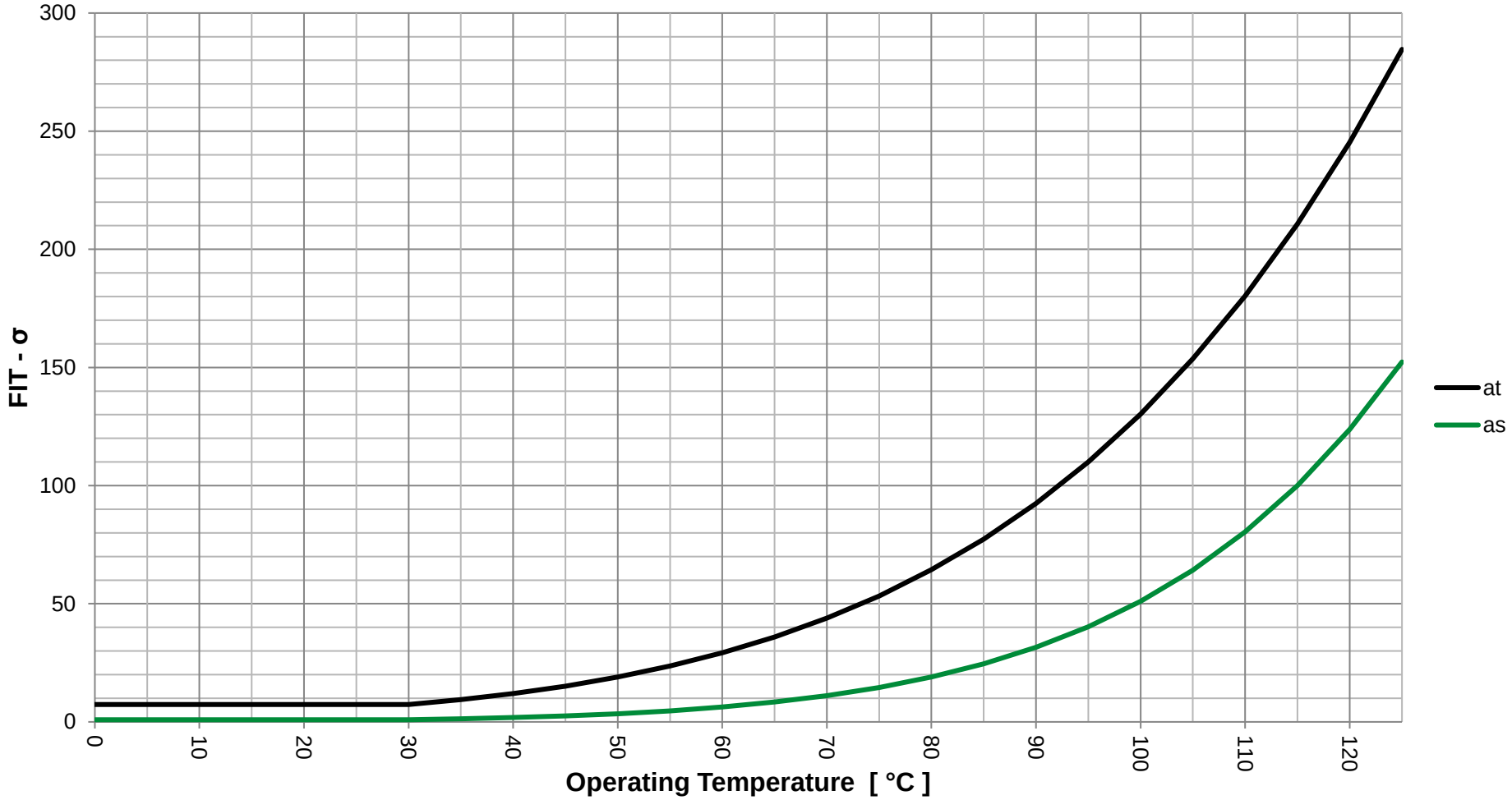
6.6 Graph σ-Values



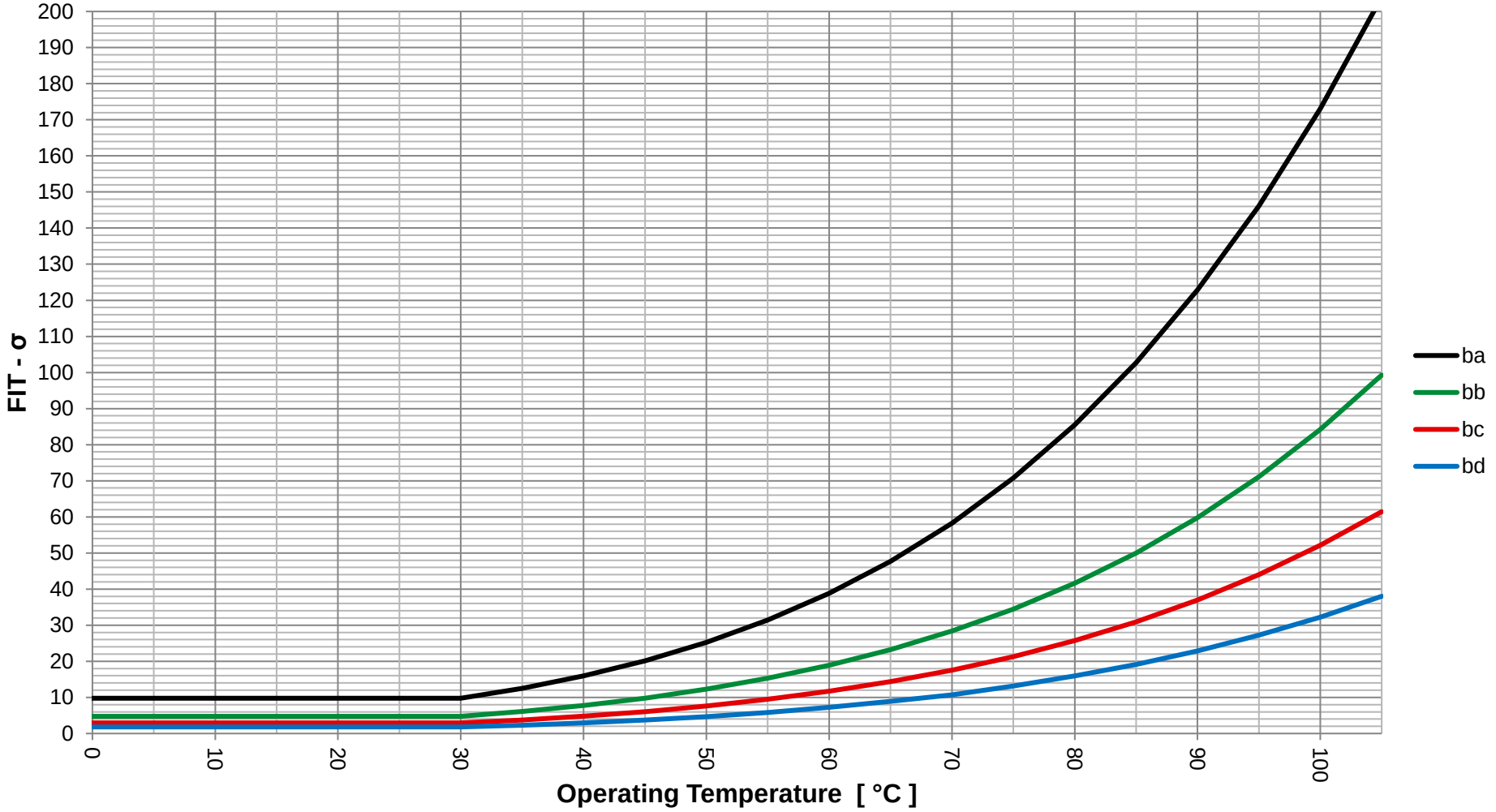
6.7 Graph σ-Values



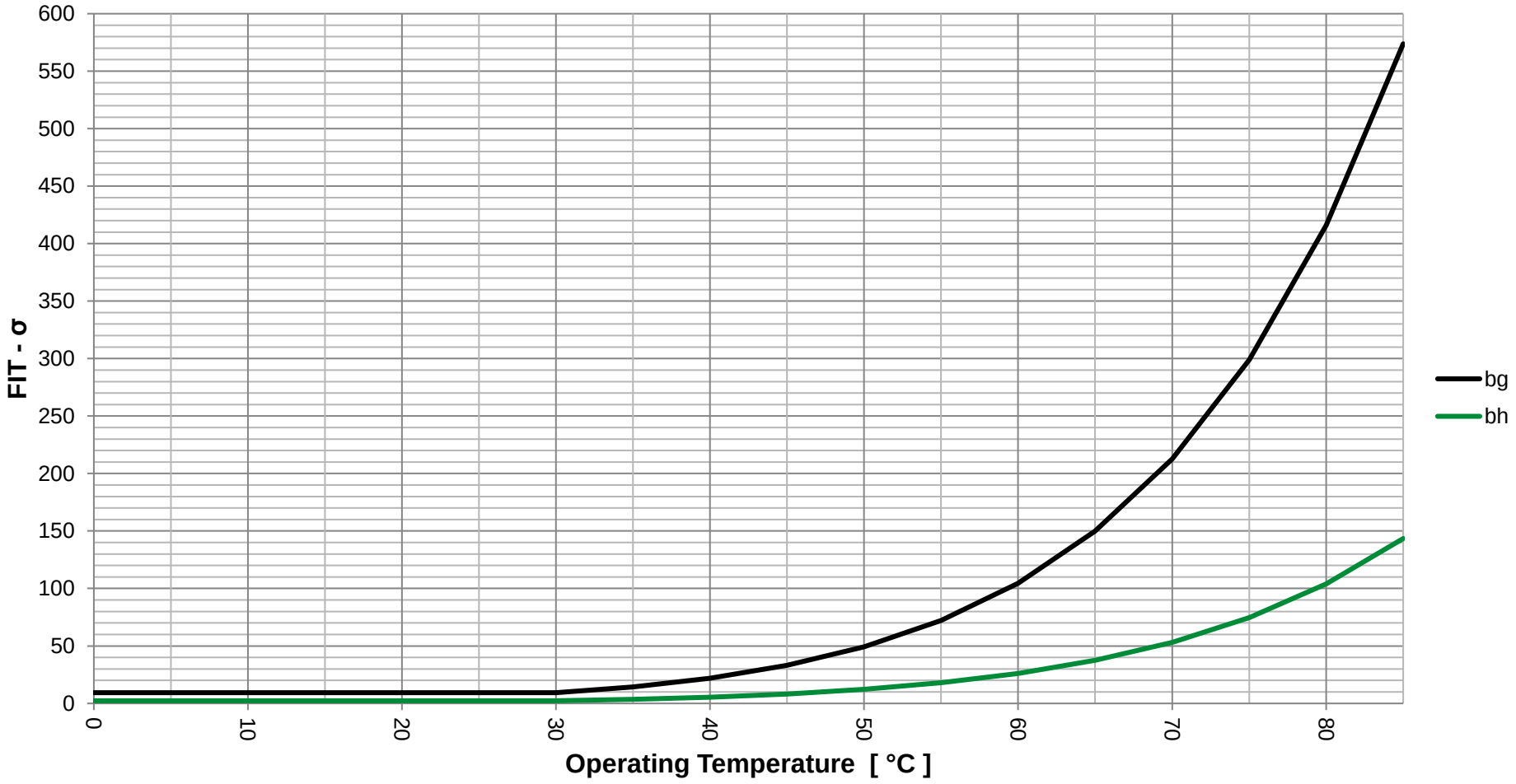
6.8 Graph σ-Values



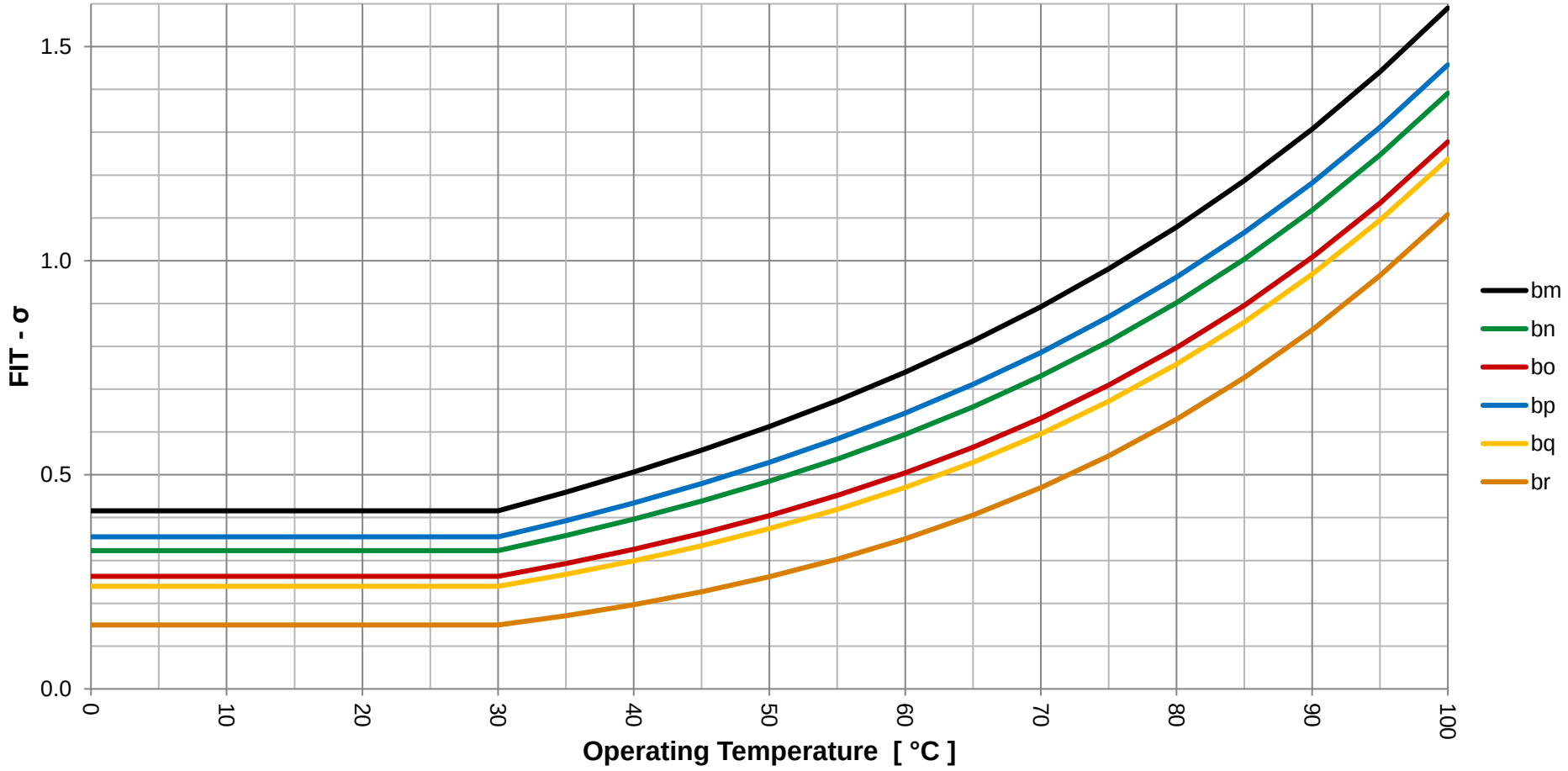
6.9 Graph σ-Values



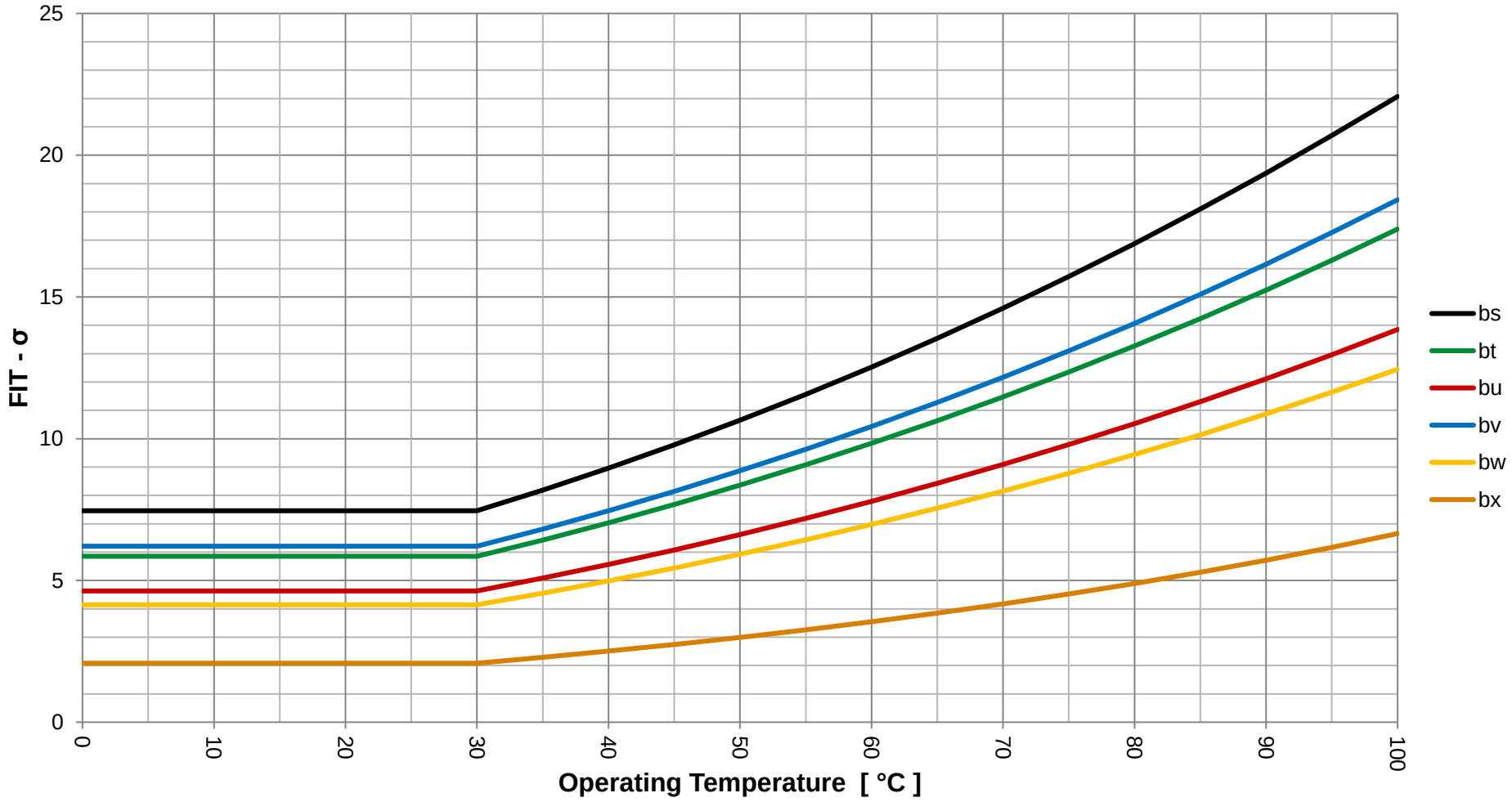
6.10 Graph σ-Values



6.11 Graph σ-Values

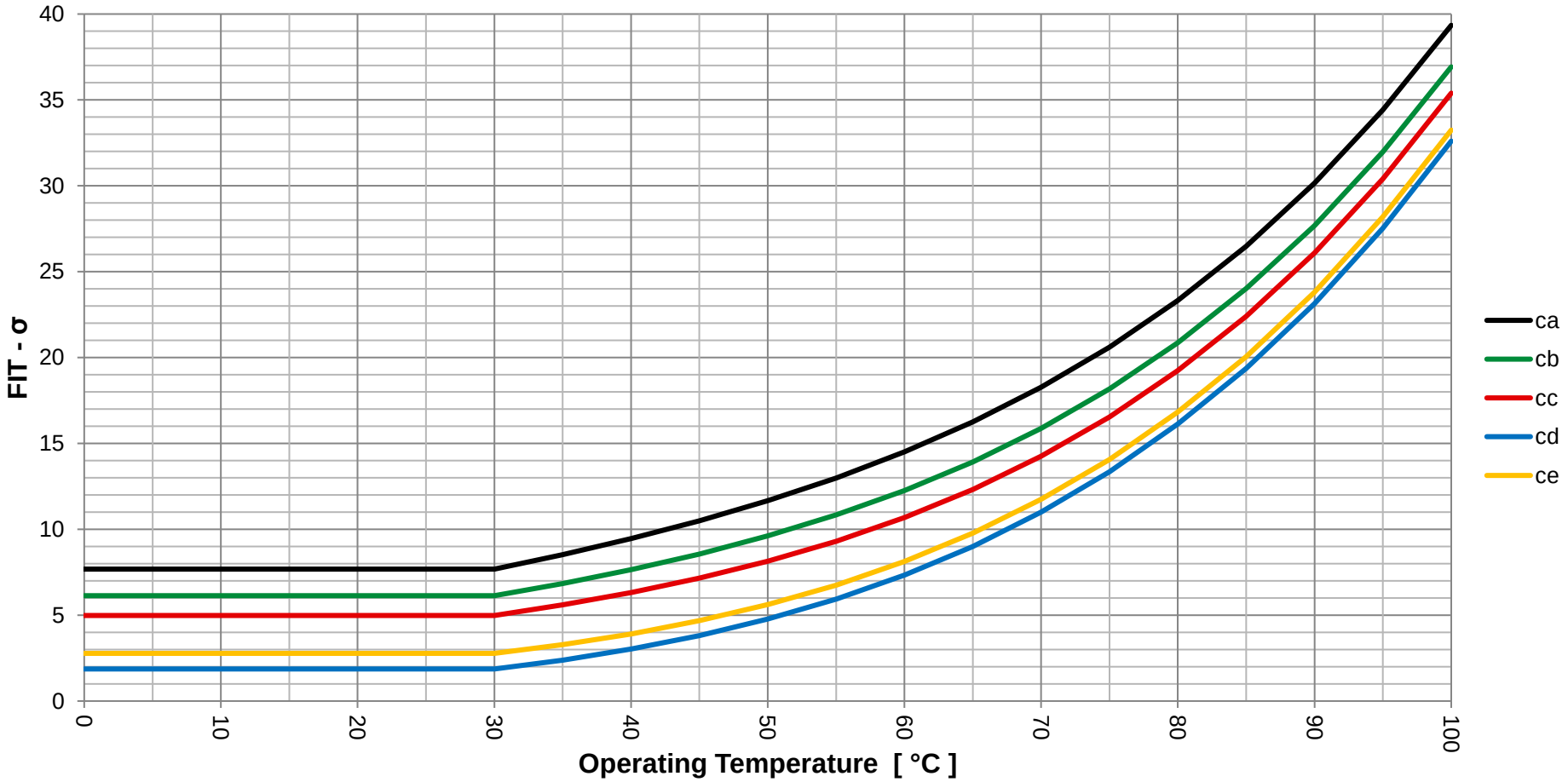


6.12 Graph σ-Values



6.13 Graph σ-Values

Failures of connectors are counted as one failure per mated *pair*. The FIT rate of WE-CLFS using connectors considers the terminals as 50% of the mated connection pair. The failure rate of the female connectors that are mated to the terminals in this component should be counted at 50%.



6.14 Graph σ-Values

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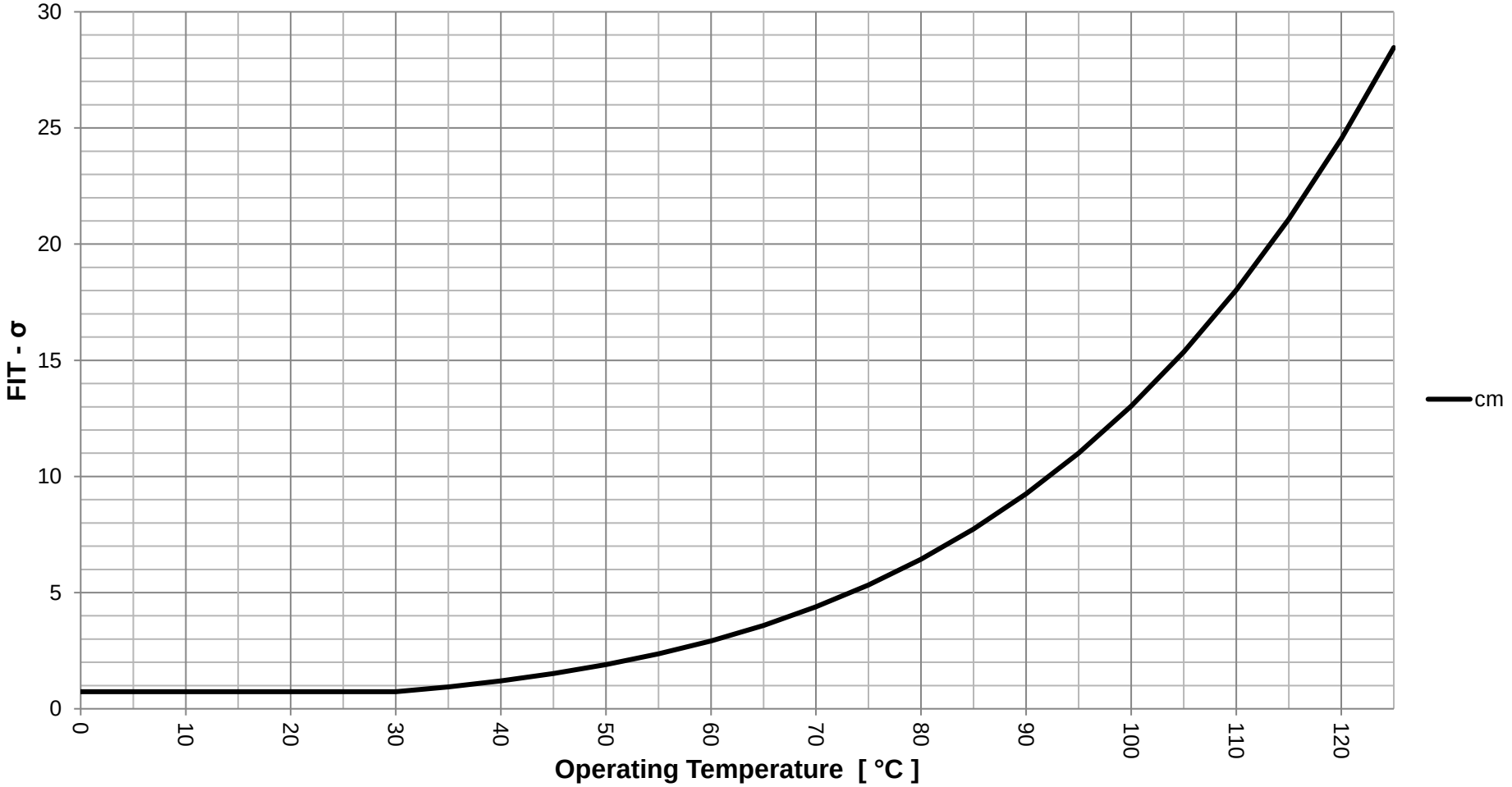
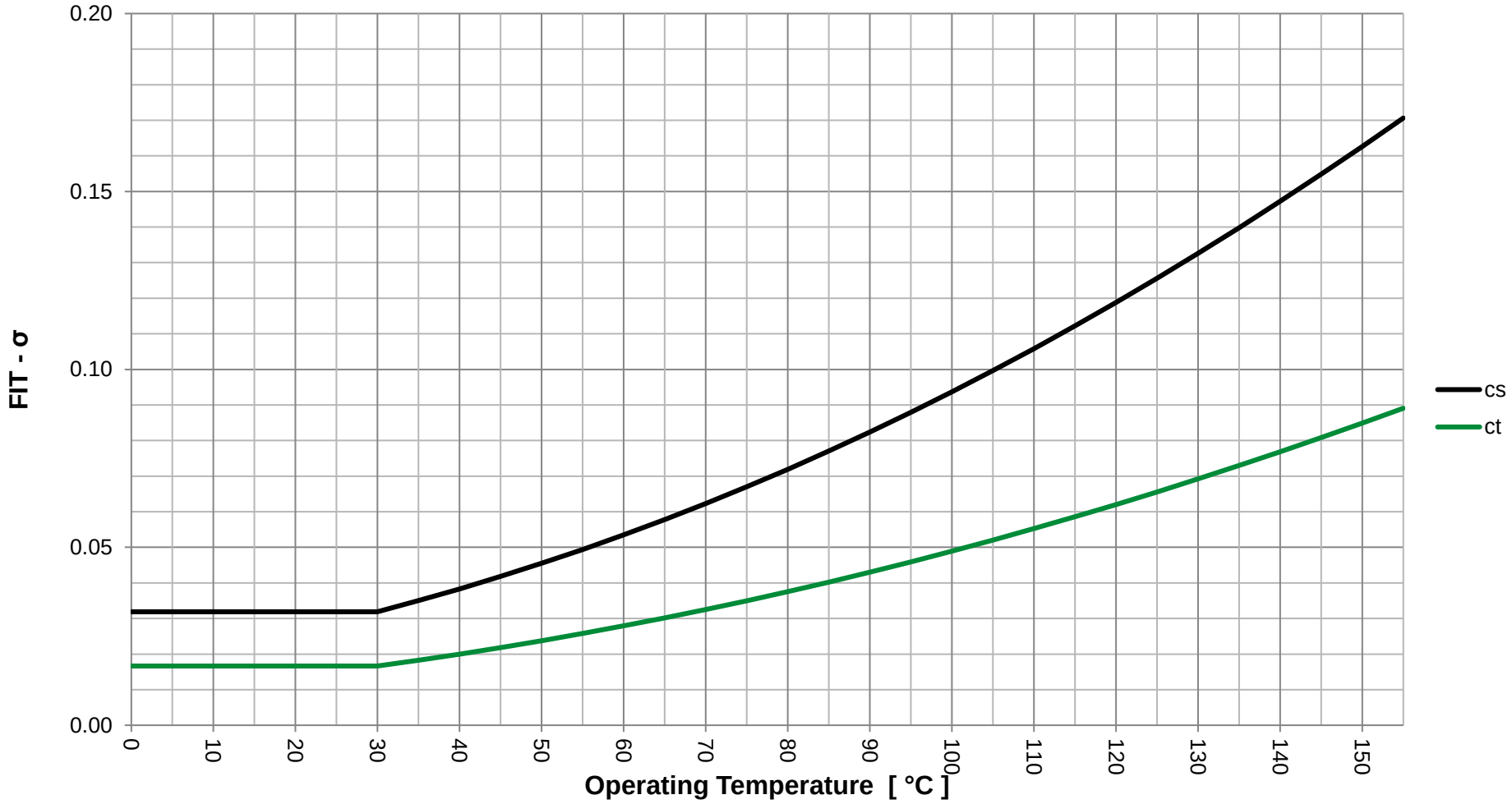
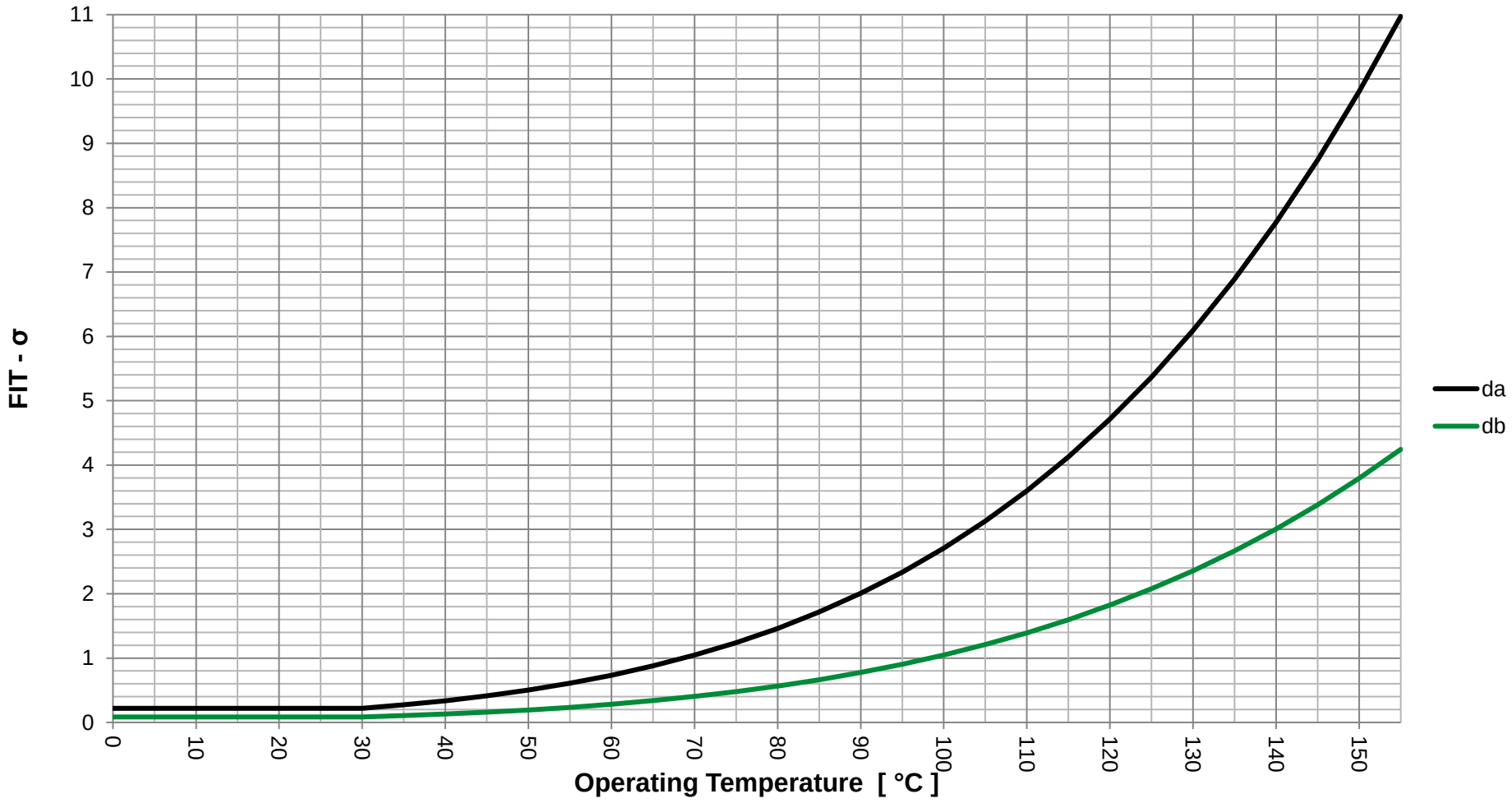
6.15 Graph σ-Values



6.16 Graph σ-Values



6.17 Graph σ-Values



7 Upper Confidence Level Calculation

The FIT rates given in this document are the mean values. However, sometimes a greater measure of certainty is desired. The Upper Confidence Level (UCL) is an estimate of the FIT rate with a certain degree of certainty. For example, a $UCL_{80\%}$ value means that there is an 80% chance that the true failure rate is less than or equal to the $UCL_{80\%}$ value.

Based on the Telcordia SR-332 Issue 3 estimations and by assuming that the failure rate follows a gamma distribution the UCL can be calculated with given mean λ and standard deviation σ as follows:

$$\text{shape } \kappa = (\lambda/\sigma)^2$$

$$\text{scale } \theta = \sigma^2/\lambda$$

The UCL is the *P*th percentile of the gamma distribution and can be calculated by the inverse cumulative gamma distribution with the shape κ and scale θ parameters as following:

$$\lambda_{P\%UCL} = G^{-1}(P/100\,;\,\kappa;\,\theta)$$

Example:
The FIT value for a WE-CMB part at 60°C, with a UCL of 80%, can be calculated as follows:

Values according to Graphs: λ= 0,34 FIT / σ= 0,10 FIT

$$\text{shape } \kappa = (0{,}34/0{,}10)^2 = 11{,}56$$

$$\text{scale } \theta = 0{,}10^2/0{,}34 = 0{,}029$$

$$\lambda_{80\%UCL} = G^{-1}(80/100\,;\;11{,}56;\;0{,}029) = \underline{0{,}42 \text{ FITs}}$$

The same calculations can be performed in Microsoft Excel. The formula notation is slightly different in the European and American versions of Excel. (semicolons vs commas as separators in the formula)

European version:

	A	B	C	D	E	F	G	H
1	**Description**	**Symbol**	**Formula**	**Value**				
2	FIT, at 60°C	λ	from graph	0,34				
3	Std dev of FIT, at 60°C	σ	from graph	0,10				
4	Shape of gamma dist.	κ	=(D2/D3)^2	11,56				
5	Scale of gamma dist.	θ	=D3^2 / D2	0,029				
6	Inverse gamma distribution	$\lambda_{80\%UCL}$	=GAMMA.INV(**80**/100;D4;D5)	0,420	← FIT, with **80%** Upper Confidence Level			

American version:

6	Inverse gamma distribution	$\lambda_{80\%UCL}$	=GAMMA.INV(**80**/100,D4,D5)	0.420	← FIT, with **80%** Upper Confidence Level

8 FAQ

8.1 What is a Failure Rate?

A Failure Rate describes the failure performance of a product throughout the product life cycle. FIT and MTBF are figures to describe the failure rate and these are used for reliability calculations.

8.2 What is the FIT value λ?

The FIT value λ describes the "Failures in Time“ and is a key figure for the reliability of a product. λ gives the predicted failures per 10^9 hours (114k years) of operation during the steady state region of its expected lifetime. (See the figure in section 8.1.6)

8.3 What is the FIT value σ?

The FIT value σ is the standard deviation of the FIT value λ. It is an indicator of the variability of the FIT value λ from the mean.

8.4 What is MTBF?

MTBF is the acronym for Mean Time Between Failures and is defined as the expected value of the failure-free time between failures during the steady state region of its expected lifetime. It is an inverse function of the FIT rate.

8.5 How do I convert the FIT values to MTBF or the other way around?

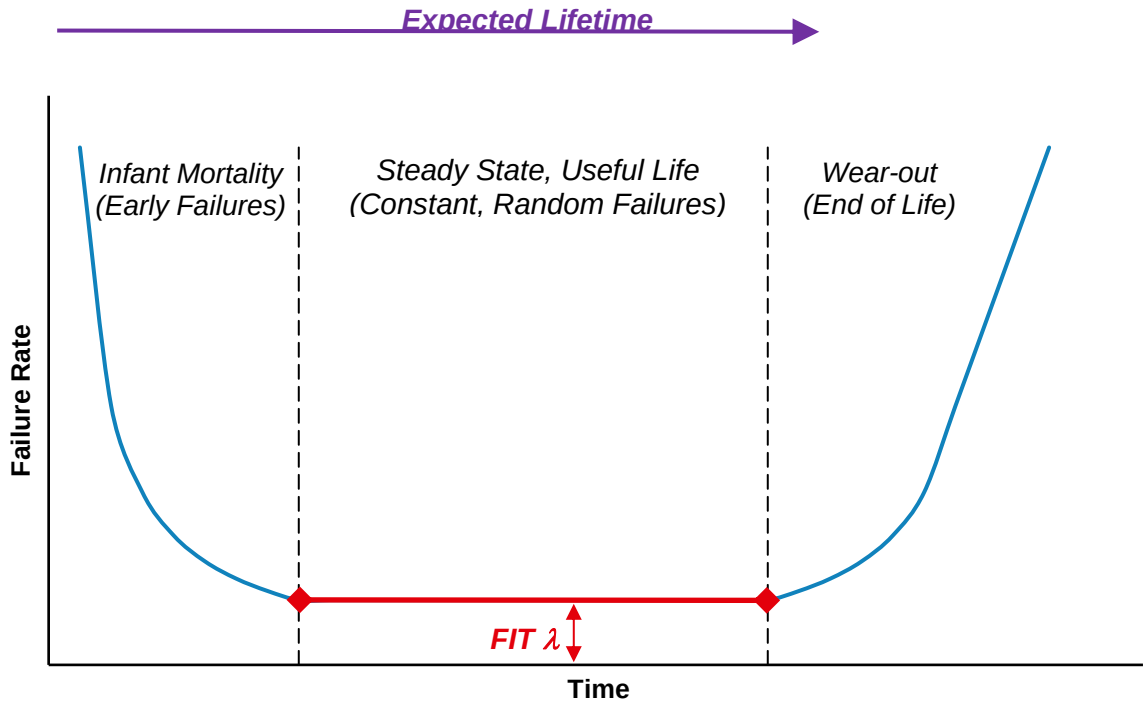
Since MTBF and FIT are just 2 different kinds to describe the failure rate, they can be converted by the formulas given below:

$$MTBF = \frac{10^9}{FIT} \qquad FIT = \frac{10^9}{MTBF}$$

8.6 Is MTBF the same as life expectancy?

As MTBF and life expectancy are both expressed in units of time, sometimes MTBF is assumed to be the life expectancy of the product. However, there is not a direct relation between MTBF and life expectancy. FIT and MTBF do not consider the early failures and wear-out failures, but rather they are a measure of random failures during the normal, useful life of the product ("Steady State" region in the figure below).

In short, FIT and MTBF correspond to the general reliability of the product, whereas life expectancy corresponds to longevity.



8.7 How can MTBF be longer than life expectancy?

The Mean Time Between Failures determination considers the total operating hours of all quantities of the part, not just of a single part. Most individual parts will not fail during the steady state region, which is the region that MTBF and FIT are based upon.

8.8 How long is the Infant Mortality period?

The infant mortality period (as shown in the figure in section 8.1.6) is assumed to be the first 10^4 hours, or a little more than one year.

8.9 Some product series in Chapter 4 state "Unlisted" for the FIT rate. What does this mean?

Some components do not have a defined FIT rate. This is common for relatively new product types, because there is not enough field data to predict the failure rates. Due to the nature of failure rates, data must be collected for many years before a generalization can be made.

8.10 Are there FIT rates for mechanical product types?

The Telcordia standard, as well as similar standards, provides failure rate data for most common electrical devices, but there are still many components which do not have a defined FIT rate. In general, FIT rates are not defined for components which are mechanical in nature and usually do not serve a specific electrical function. It is difficult to quantify and predict the failure of mechanical components, as failures are usually caused by external forces and vary widely by the environment or application.

Some components such as shields or cable ferrites serve an electrical function regarding radiated EMI suppression, but their function is based solely on their material properties and these components are not directly subject to current or voltage. Other components, such as thermal pads, may suffer gradual degradation over time and there is not a defining moment when the component becomes a failure. In addition, these are also highly dependent on the surrounding environment.

Remark:
The FIT reliability data provided within this document are predictions and will not be guaranteed by WE. Due to a large variance of possible mission profiles and applications WE may not provide FIT data for all products.