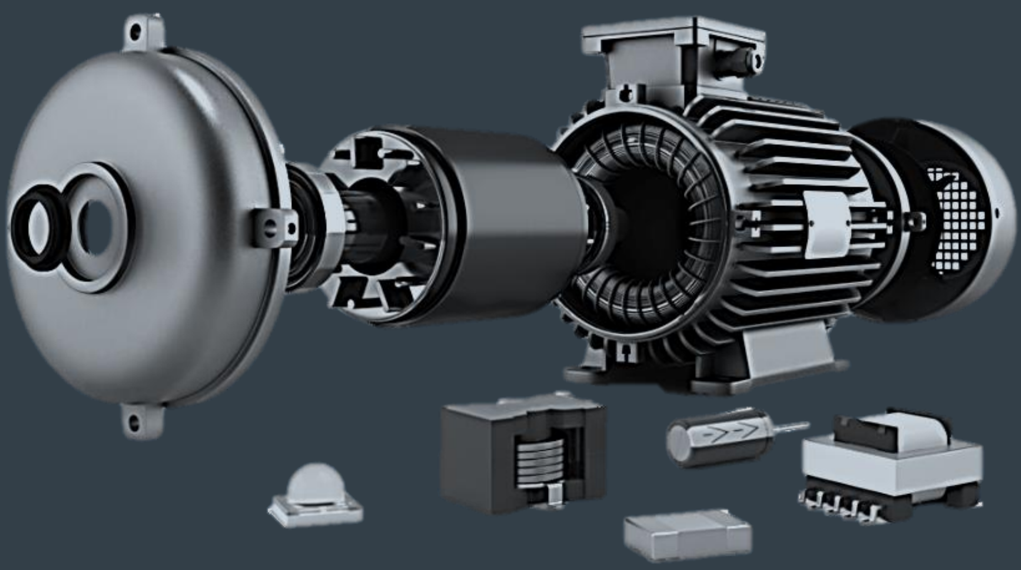

WE STANDARD:
WES_FIT – RELIABILITY DATA

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WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

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1 Document Control

Rev.	Section	Change Description	Issued by	Date:
Descriptions of previous revision changes are available upon request.				
1.26		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
1.27	2, 4.1, 4.2, 4.4, 4.5, 4.7, 4.9, 4.10, 5.9, 5.18-5.22, 6.9, 6.18-6.20, 8.7, 8.9, 8.11, 9, 10	Update document format; Add WCAP-FTDB, WCAP-FTXH, WCAP-SISC (unlisted), WE-FLYLT, WE-HEPC, WE-TORPFC, WL-SUTW, MagI3C-FIMM, MagI3C-VDLM and additional MagI3C-FDSM and MagI3C-FISM parts, section 4.10 Switches and accompanying graphs; Expand explanation in FAQ 8.7 and 8.9; Add section 8.11; Add electrical stress definitions to sections 4.1, 4.5, 4.7 and 4.10; Remove table for electrolytic caps >400uF, add note to table for electrolytic caps <400uF, and remove graphs 5.9 and 6.9; Add section 9 Referenced Documents and section 10 Disclaimer; Update document footer	TKa	14.03.2023
1.28	4.10, 5.23, 5.24, 6.21, 6.22, 4.4, 4.5, 4.2, 4.3, 5.25 & 6.23, 5.26 & 6.24 & 4.11, 5.28 & 6.26	Added: WS-TOTV SPDT, WS-TOTV DPDT, WL-SMRD, WCAP-HTG5, WCAP-HTAH, WCAP-HSG5, WCAP-HSG5, WE-HEPA, WE-HCFAT, WE-BMS, WL-ICLED, WE-PLC, WE-BMS, WL-OCTR Changes: none Deleted: none	SvL	21.06.2024

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.

Würth Elektronik 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 and the example in the chapter ***Upper Confidence Level Calculation***, the increase of temperature directly influences the FIT data (λ and σ). 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. The base factors for later product / module reliabilities are being set directly during the design stage.

FIT and MTBF rates are an estimation of the *random* failures that occur over a population of a product type, and do not account for failures due to manufacturing defects (early failures) or wear-out failures. More explanation can be found in the chapter ***Frequently Asked Questions***. All FIT rates are predictive values with a degree of uncertainty. This can be observed by the significant value differences amongst well-known and oft-used standards such as SR-332, MIL-HDBK-217, and SN29500. Actual electronic failure rates are difficult to measure and only begin to become evident after years of data collection and observation. Therefore, the FIT values provided in this document are **predictions** based on the type of component, and are neither tested nor guaranteed by Würth Elektronik.

3 Determination of FIT values

FIT values for specific products can be obtained by the following process:

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 may 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					

		FIT - λ		FIT - σ	
Series	Product Category	Graph	Curve	Graph	Curve
WE-SL	Coil, Power Filter	5.1	B	6.1	d
WE-SL1					
WE-SL2					
WE-SL3					
WE-SL5					
WE-SL5 HC					
WE-SLM					
WE-TFC					
WE-TPB					
WE-TPBHV					
WE-UCF					
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					

Electrical stress of following components is defined as $\frac{actual\ power}{rated\ power}$ or $\frac{average\ forward\ current}{rated\ forward\ current}$.

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

Electrical stress of WE-CLFS line filters is determined by the equivalent electrical stress percentage of individual subcomponents. See electrical stress definitions in sections 4.5 and 4.7.

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

4.2 Power Magnetics

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-CFWI	Coil, Load Coil	5.1	A	6.1	b
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-HCFAT					
WE-HCFT					
WE-HCI					
WE-HCIA					
WE-HCIT					
WE-HCLW					
WE-HCM					
WE-HCRW					
WE-HEPA					
WE-HEPC					
WE-HIDA					
WE-LHCA					
WE-LHMD					
WE-LHMI					
WE-LQ					
WE-LQFS					

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-LQS	Coil, Load Coil	5.1	A	6.1	b
WE-LQS ECO					
WE-LQSH					
WE-MAIA					
WE-MAPI					
WE-MCRI					
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					
WE-PMCI					
WE-PMI					
WE-PMMI					
WE-SI					
WE-SPC					
WE-TDC					

		FIT - λ		FIT - σ	
Series	**Product Category**	**Graph**	**Curve**	**Graph**	**Curve**
WE-TI WE-TI eco WE-TI HV WE-TIF WE-TIS WE-TORPFC WE-TPC WE-WPCC WE-XHMA WE-XHMI Custom Power Inductor	Coil, Load Coil	5.1	A	6.1	b
WE-CST WE-GDT WE-GDTI	Transformer, Pulse Low Level	5.2	J	6.2	j
WE-AGDT WE-FB WE-FB3751 WE-FLEX WE-FLEX+ WE-FLEX HV WE-FLYLT WE-LLCR WE-PoE WE-PoE+ WE-PoEH WE-PPTI WE-Unit WE-UOST Custom Power	Transformer, Power (> 1W)	5.2	G	6.3	m

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	Coil, Chip/Ceramic Filter		5.1	C	6.1	d
WE-BPF						
WE-CCMF						
WE-KI						
WE-KI HC						
WE-LPF						
WE-MCA						
WE-MCI						
WE-MK						
WE-RFH						
WE-RFI						
WE-TCI						
WE-CAIR	Coil, Radio Frequency, Fixed		5.1	C	6.1	f
WE-ACHC						
WE-BMS	Transformer, Radio Frequency		5.3	Q	6.3	p
WE-LAN						
WE-LAN AQ						
WE-LAN 10G						
Custom LAN						
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-BMS	Transformer, Pulse Low Level		5.2	J	6.2	J
WE-STST						
Custom Signal						

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					

		FIT - λ		FIT - σ	
Series	Product Category	Graph	Curve	Graph	Curve
WL-SICW	Single LED	5.4	T	6.4	t
WL-SIMW					
WL-SIQW					
WL-SIRW					
WL-SISW					
WL-SITW					
WL-SMCC					
WL-SMCD					
WL-SMCW					
WL-SMDC					
WL-SMRD					
WL-SMRW					
WL-SMSW					
WL-SMTD					
WL-SMTW					
WL-SUMW					
WL-SUTW					
WL-SWTC					
WL-SWTP					
WL-TIRC					
WL-TIRW					
WL-TMRC					
WL-TMRW					
WL-VCSL					
WL-S7DS	LED 7-segment display	5.4	S	6.4	s
WL-T7DS					

			FIT - λ		FIT - σ	
Series	Product Category		Graph	Curve	Graph	Curve
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						
WL-OCTR	Optocoupler, Triac output		5.28	GA	6.26	fa
WL-ICLED 4 pin	**ICLED with Controller**	**100%**	5.25	**FK**	6.23	**ek**
WL-ICLED 6 pin		**50%**	5.25	**FL**	6.23	**el**

4.5 Capacitors

Electrical stress of capacitors is defined as $\frac{applied\ DC\ voltage + AC\ peak\ voltage}{rated\ voltage}$.

			FIT - λ		FIT - σ	
Series	Product Category	Electrical Stress	Graph	Curve	Graph	Curve
WCAP-AI3H WCAP-AIE8 WCAP-AIG5 WCAP-AIG8 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-HTG5* WCAP-HTAH* WCAP-HSG5* WCAP-HSAH* WCAP-PHET WCAP-PHGP WCAP-PHLE WCAP-PHSE WCAP-PSHP WCAP-PSLC WCAP-PSLP WCAP-PTG5 WCAP-PTHR WCAP-PTHT	Fixed, Aluminum, Electrolytic, Fixed, < 400 µF	30% 50% 70% 100%	5.6 5.6 5.6 5.6	AJ AI AH AG	6.6 6.6 6.6 6.6	aj ai ah ag

WCAP-PT5H						
For capacitance values > 400 µF, double the FIT value.						

*The matchcodes marked with an * are aluminium hybrid components. The Telcordia Standard is not delivering detailed information about this kind of parts, so WE decided to use the best match.

			FIT - λ		FIT - σ	
Series	Product Category	Electrical Stress	Graph	Curve	Graph	Curve
WCAP-FTBE WCAP-FTBP WCAP-FTDB WCAP-FTX2 WCAP-FTXX WCAP-FTXH	Fixed, Plastic	30% 50% 70% 100%	5.5 5.5 5.5 5.5	AD AC AB AA	6.1 6.1 6.1 6.3	e c a n
WCAP-CSGP WCAP-CSMH WCAP-CSRF WCAP-CSSA WCAP-CSST	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-STSC WCAP-SISC	Super Capacitors	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 Resistors

Electrical stress of resistors is defined as $\frac{applied\ power}{rated\ power}$.

			FIT - λ		FIT - σ	
Series	**Product Category**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WRIS-KSKE WRIS-KWKB WRIS-KWKH	Fixed, Film (Carbon, Oxide, Metal), ≤1 Megohm	**50%** **100%**	5.16 5.16	**CT** **CS**	6.16 6.16	**ct** **cs**
WRIS-PSMB WRIS-PSMC WRIS-PWMC WRIS-RSKS	Fixed, Composition, ≤1 Megohm	**50%** **100%**	5.17 5.17	**DB** **DA**	6.17 6.17	**db** **da**
WRIS-RSKS	Fixed, Composition, ≥1 Megohm	**50%** **100%**	5.27	FT FU	6.25	et eu

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 WP-BUFU WP-BUTR WP-RAFU WP-RATR WP-SHFU WP-TGCF WP-TGTR WP-TPSE	General Purpose, Power ***See Press Fit note below*	5.15	CM	6.15	cm
WP-SMBU WP-SMSH WP-SMRT WP-THRBU WP-THRSH	General Purpose, Power	5.15	CM	6.15	cm

** 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 / 173950375 or 173950575	**25 °C** **75 °C**	**191** **446**
	SIP-3 / 173950*x*78 or 173010*x*78	**25 °C** **70 °C**	**239** **458**
	SIP-3 / 173951275	**25 °C** **75 °C**	**195** **487**
MagI³C-FIMM	LGA-7 / 1769205132	**25 °C** **125 °C**	**29** **61.5**
MagI³C-FISM	SIP-4 / 1779205*x*1	**25 °C** **85 °C**	**44.7** **108**
	SIP-4 / 1779205111	**25 °C** **85 °C**	**186** **617**
	SIP-4 / 1779205211 or 1779205311	**25 °C** **85 °C**	**186** **546**
	SIP-4 / 1779405*x*11	**25 °C** **85 °C**	**43** **129**
	SIP-7 / 1779205141	**25 °C** **85 °C**	**186** **617**
	SIP-7 / 1779205241 or 1779205341	**25 °C** **85 °C**	**186** **546**
	Continued on next page		

		FIT - λ	
Series	**Size / Order Code**	**Condition**	**Value**
MagI³C-FISM	SIP-7 / 1779205*x*4	25 °C 85 °C	75.8 192
	SIP-7 / 1779405141	25 °C 100 °C	43 178
	SIP-7 / 1779405241 or 1779405341	25 °C 100 °C	29 119
	SMT-8 / 1769205*x*2 or 1768*x*1*x*12	25 °C 100 °C	333 1053
	SMT-8 / 1769205141	25 °C 100 °C	35.3 191
	SMT-8 / 1769205241 or 1769205341	25 °C 100 °C	29.3 173
	SMT-8 / 1769405*x*41	25 °C 100 °C	43.6 207
MagI³C-LDHM	TO263-7EP / 172946001	55 °C	1.81
MagI³C-VDLM	LGA-12EP / 1710*x*3801	55 °C	0.100
	LGA-16EP / 1710*x*1801	55 °C	0.029
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
	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

4.10 Switches

The failure rates for illuminated switches do not account for the LED component of the switch, as such failures generally do not constitute a system function failure. To account for failures of the illumination, the user can simply add the failure rate of an LED component.

Electrical stress of switches is defined as $\frac{contact\ current}{rated\ current}$.

				FIT - λ		FIT - σ	
Series	**Product Category**	**Poles/ Throws**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WS-PBSU WS-PBTU WS-PBTL	Push Button Switches		25% 50% 75% 100%	5.18	DG DH DI DJ	6.18	dg dh di dj
WS-RSTV	Rocker Switches	SPST	25% 50% 75% 100%	5.19	DM DN DO DP	6.19	dm dn do dp
		DPST	25% 50% 75% 100%	5.20	DS DT DU DV	6.19	dm dn do dp
WS-ROSV WS-ROTU WS-ROTV	Rotary DIP Switches		25% 50% 75% 100%	5.22	EG EH EI EJ	6.20	ds dt du dv
WS-SLSU WS-SLSV WL-SLTU WS-SLTV	Slide Switches	SPDT	25% 50% 75% 100%	5.20	DS DT DU DV	6.19	dm dn do dp
		DPDT	25% 50% 75% 100%	5.21	EA EB EC ED	6.19	dm dn do dp

				FIT - λ		FIT - σ	
Series	**Product Category**	**Poles/ Throws**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WS-TOTV	Toggle Switch	**SPDT**	**25%**	5.23	FA	6.21	ea
			50%		FB		eb
			75%		FC		ec
			100%		FD		ed
		DPDT	**25%**	5.24	FG	6.22	eg
			50%		FH		eh
			75%		FI		ei
			100%		FJ		ej
WS-DESU	Detector Switches	Unlisted					
WS-DESV							
WS-DISV	Dip Switches	Unlisted					
WS-DITU							
WS-ENTV	Encoder Switches	Unlisted					
WS-RPTL	Illuminated Rotary Push Button Switch	Unlisted					
WS-MITV	Micro Switches	Unlisted					
WS-TASL	Tact Switches	Unlisted					
WS-TASU							
WS-TASV							
WS-TATL							
WS-TATU							
WS-TATV							

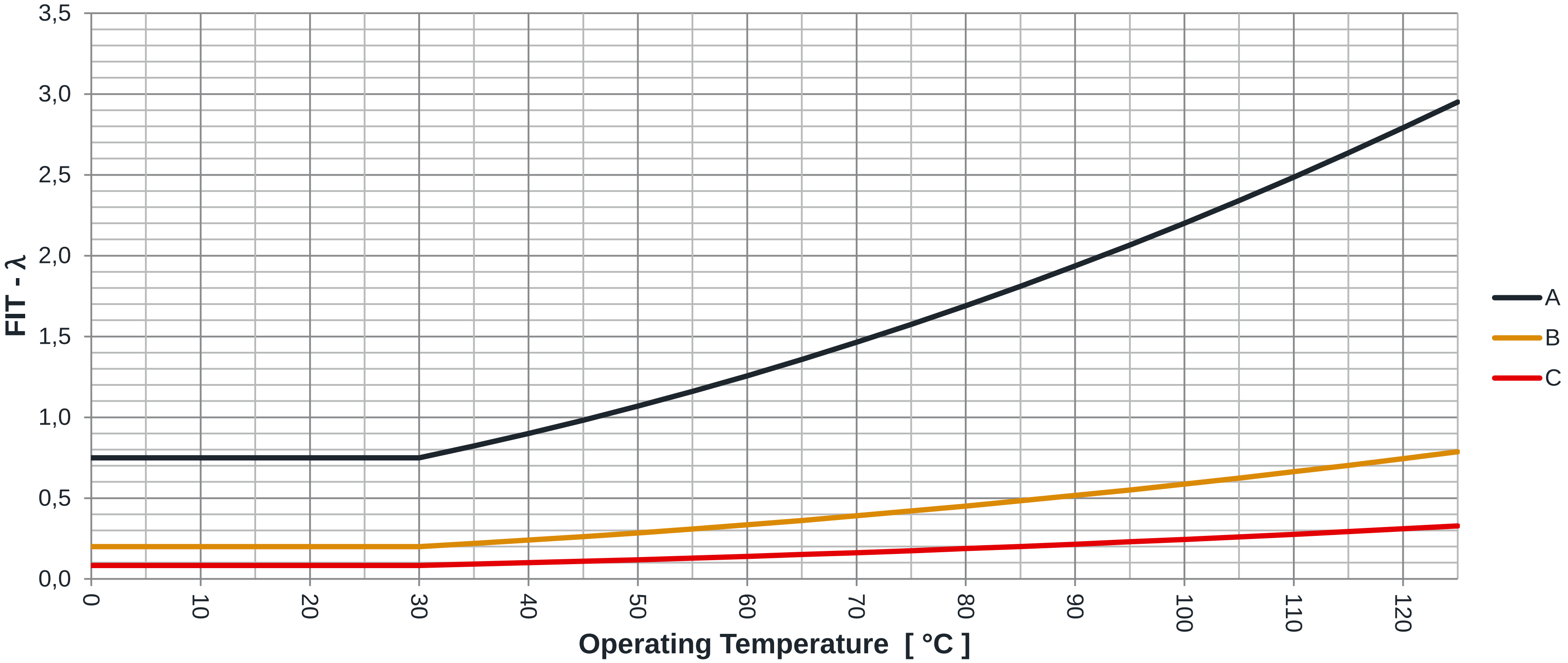
4.11 Transformers

Electrical stress of switches is defined as $\frac{contact\ current}{rated\ current}$.

				FIT - λ		FIT - σ	
Series	**Product Category**	**Poles/ Throws**	**Electrical Stress**	**Graph**	**Curve**	**Graph**	**Curve**
WE-PLC (1 Ch)	Transformer		**100%**	5.25	FO	6.18	eo
WE-BMS (1 CH)				5.25	FO	6.24	eo
WE-BMS (2 CH)				5.25	FP	6.24	ep

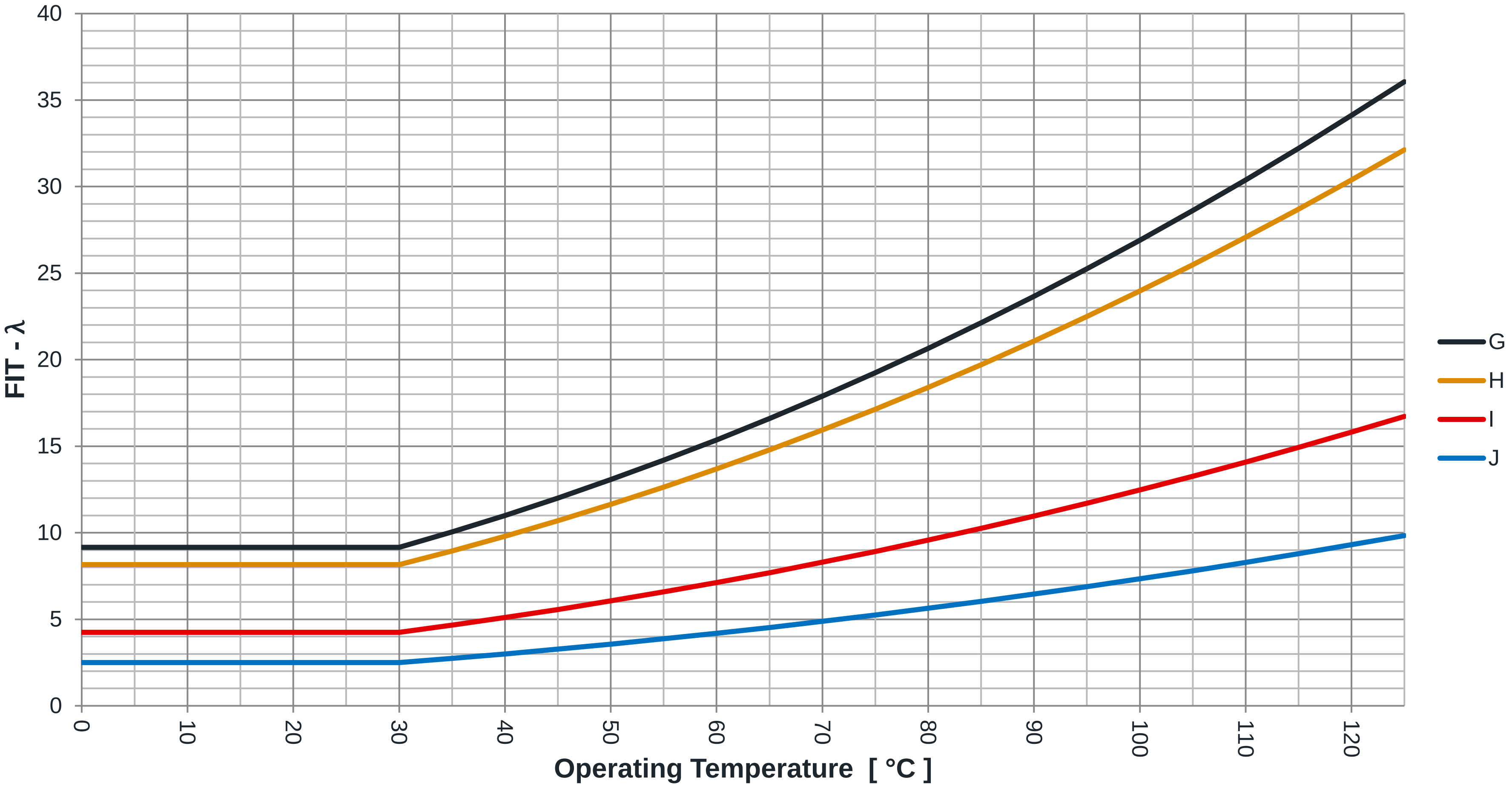
5 λ Graphs

5.1 Graph λ-Values

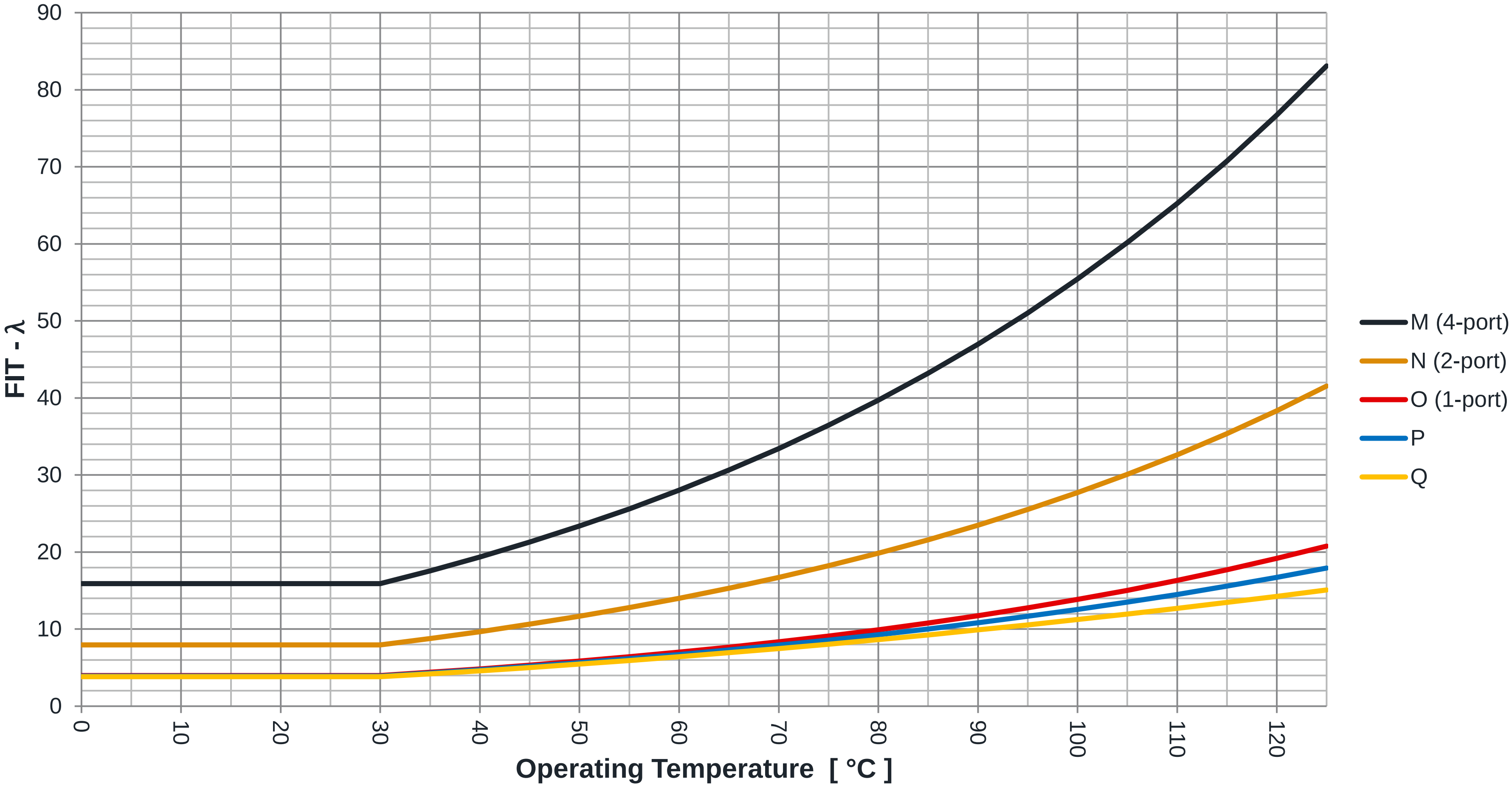


The FIT reliability data provided within this document are predictions and are not guaranteed by Würth Elektronik.
The provided reliability data shall not be deemed as statements, representations or warranty on behalf of the supplier of the calculation models.

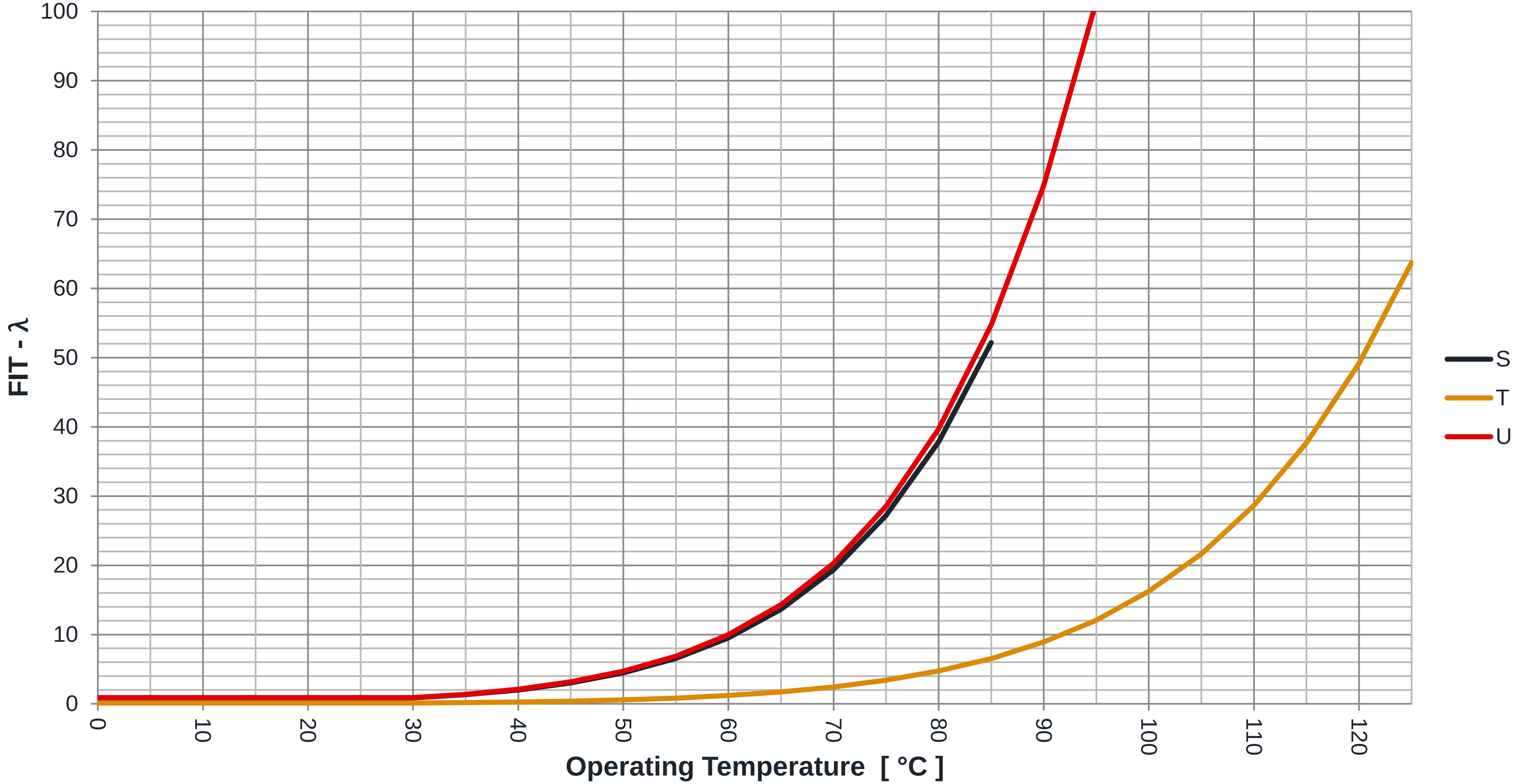
5.2 Graph λ-Values



5.3 Graph λ-Values



5.4 Graph λ-Values



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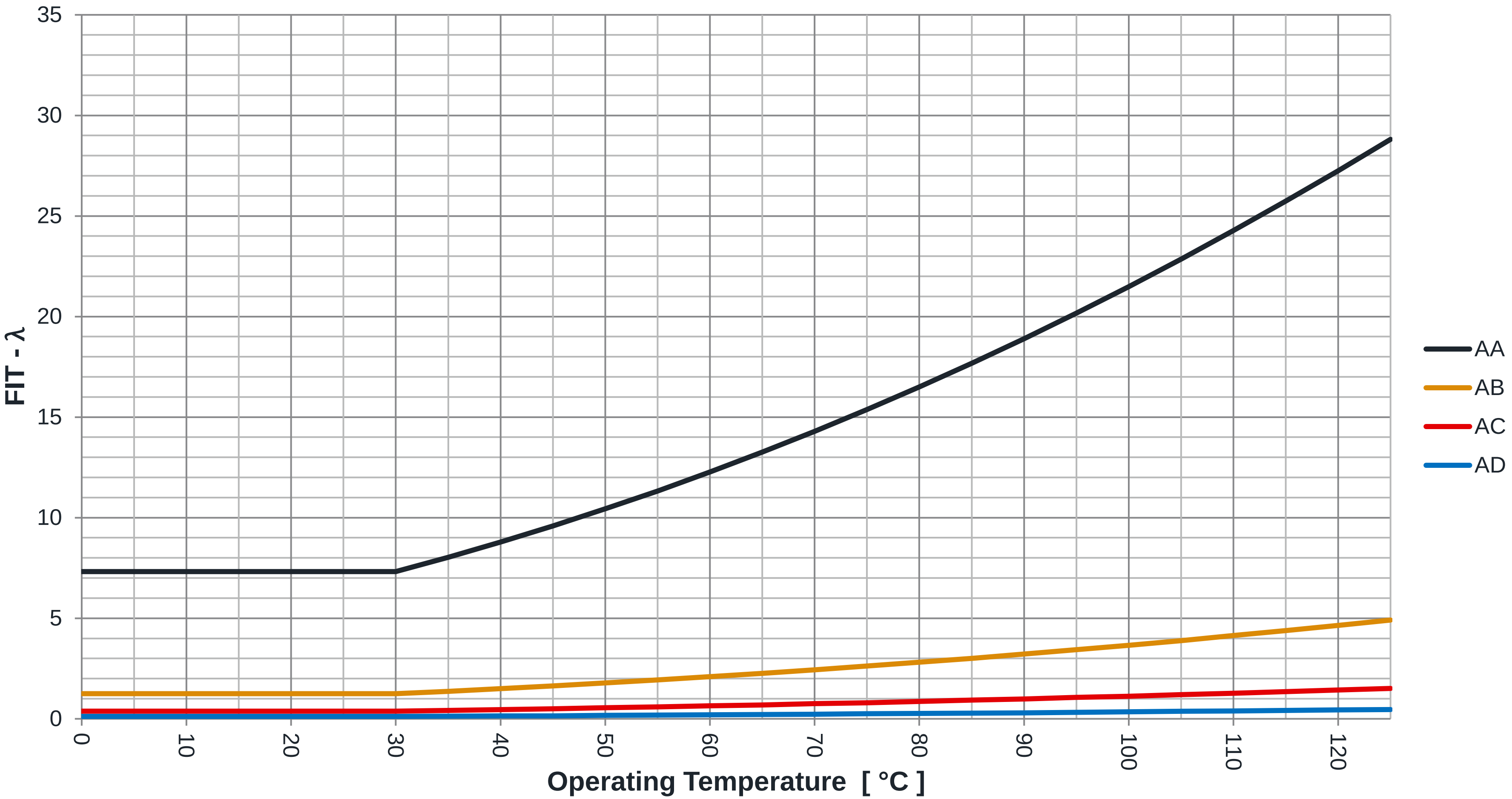
5.5 Graph λ-Values



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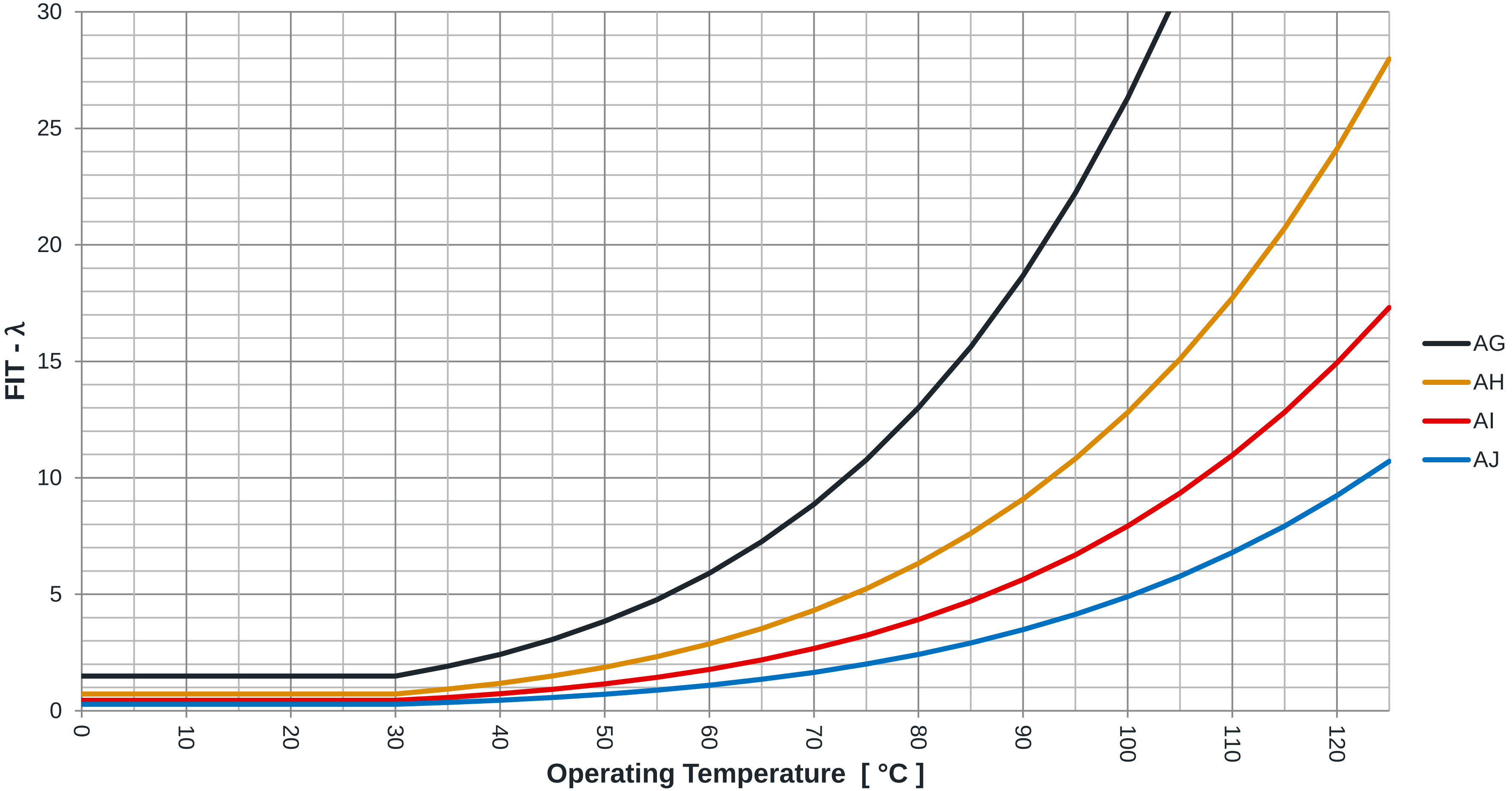
5.6 Graph λ-Values



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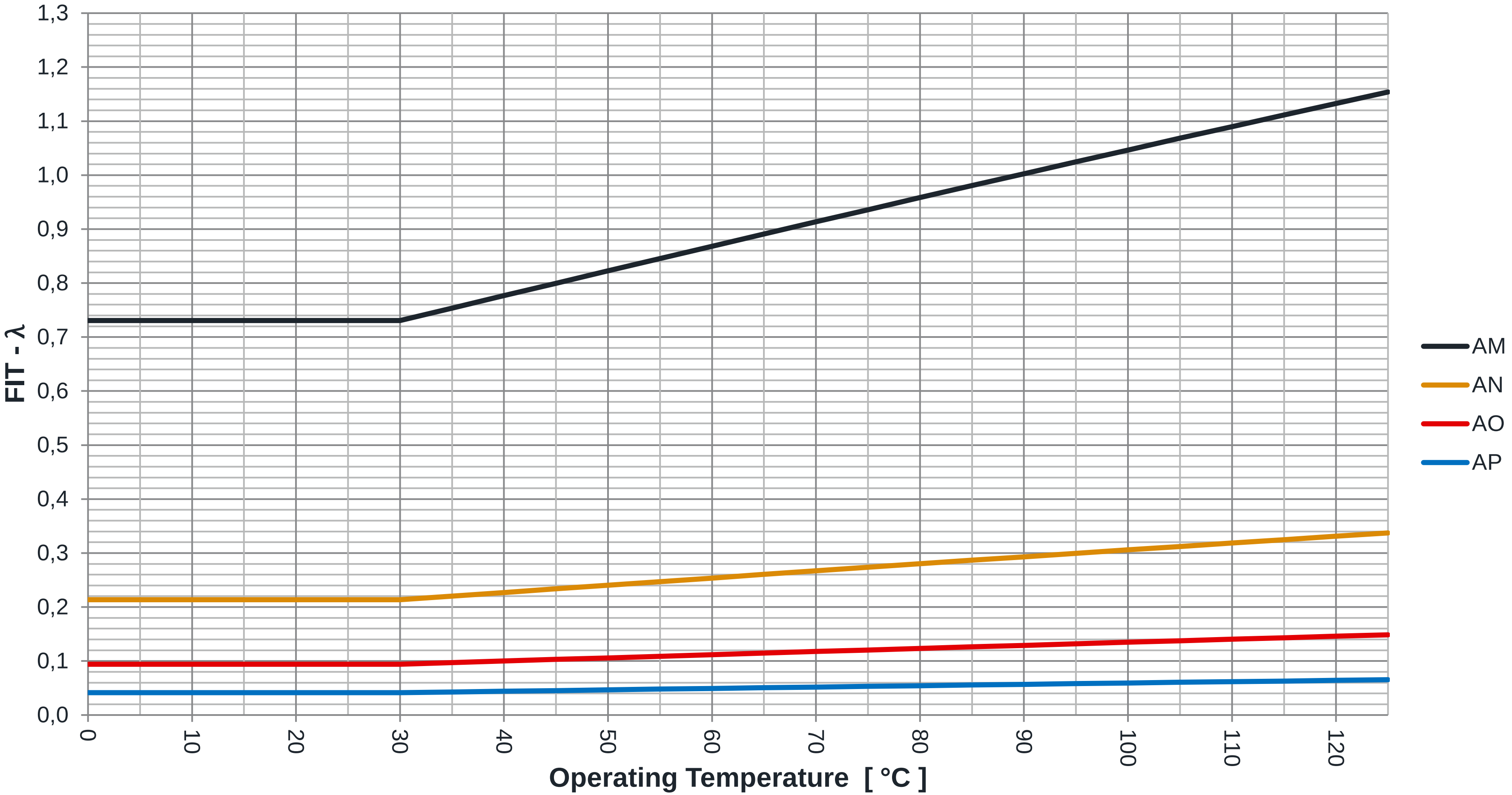
5.7 Graph λ-Values



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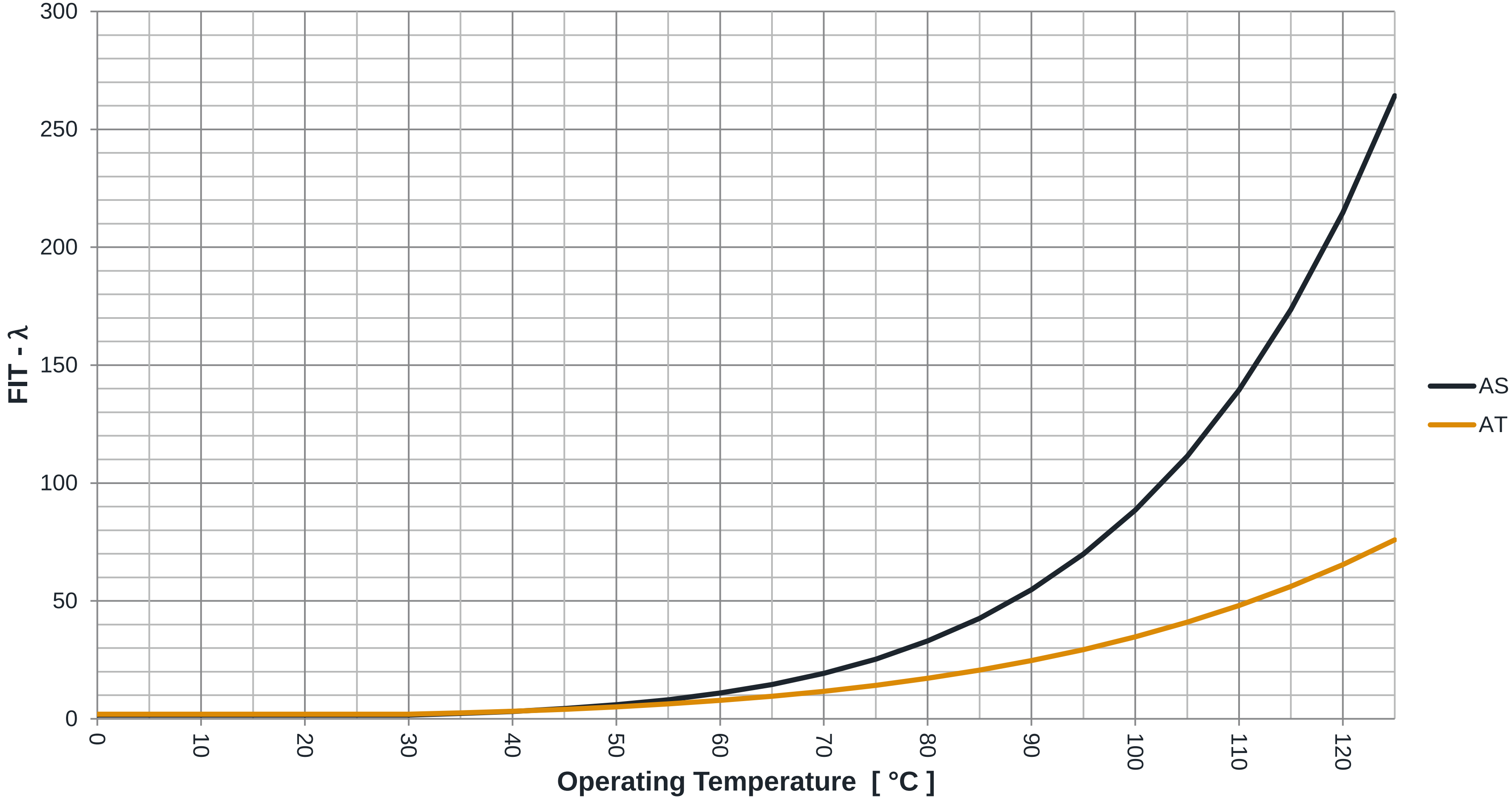
5.8 Graph λ-Values



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5.9 Graph λ-Values

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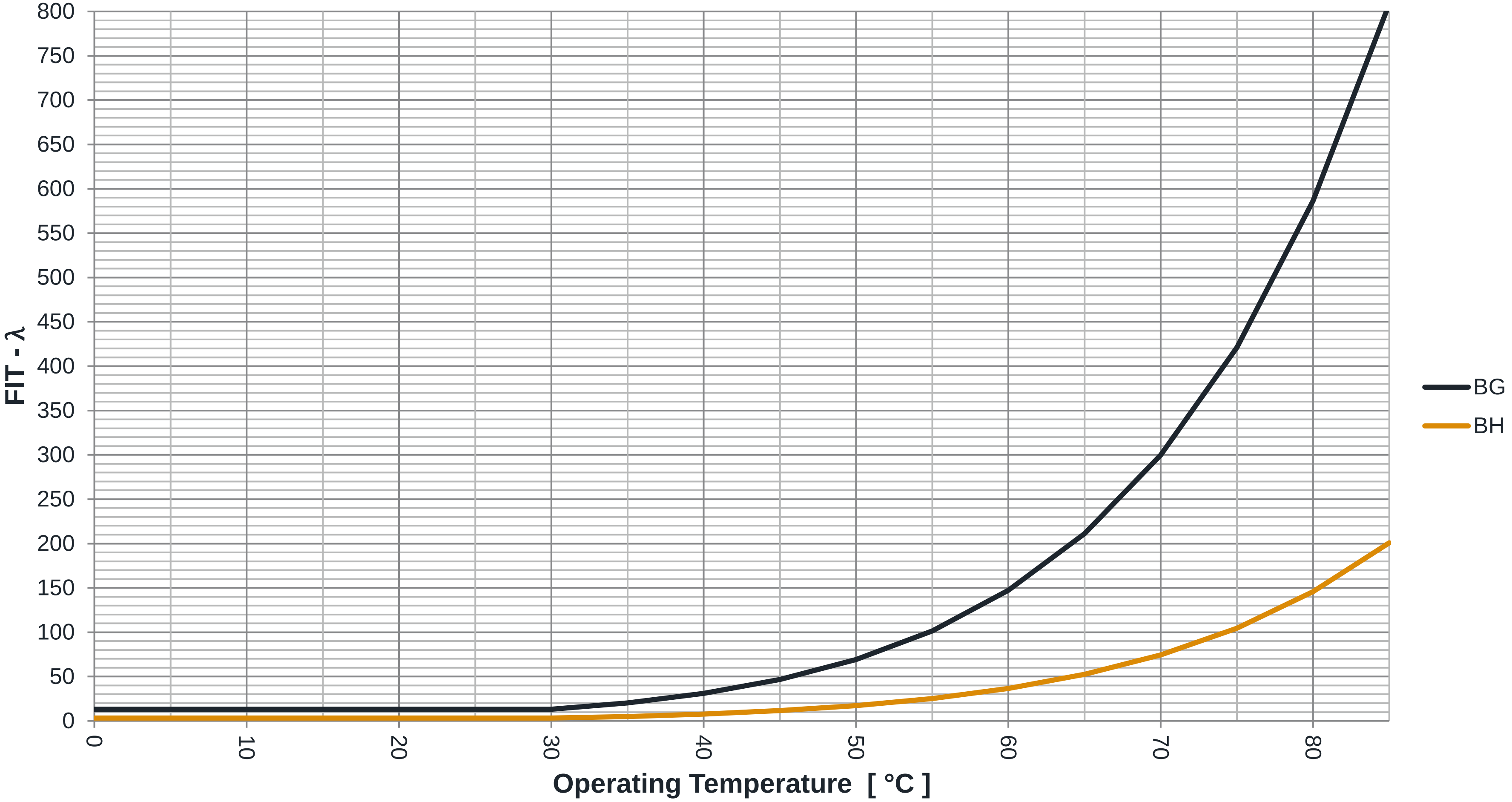
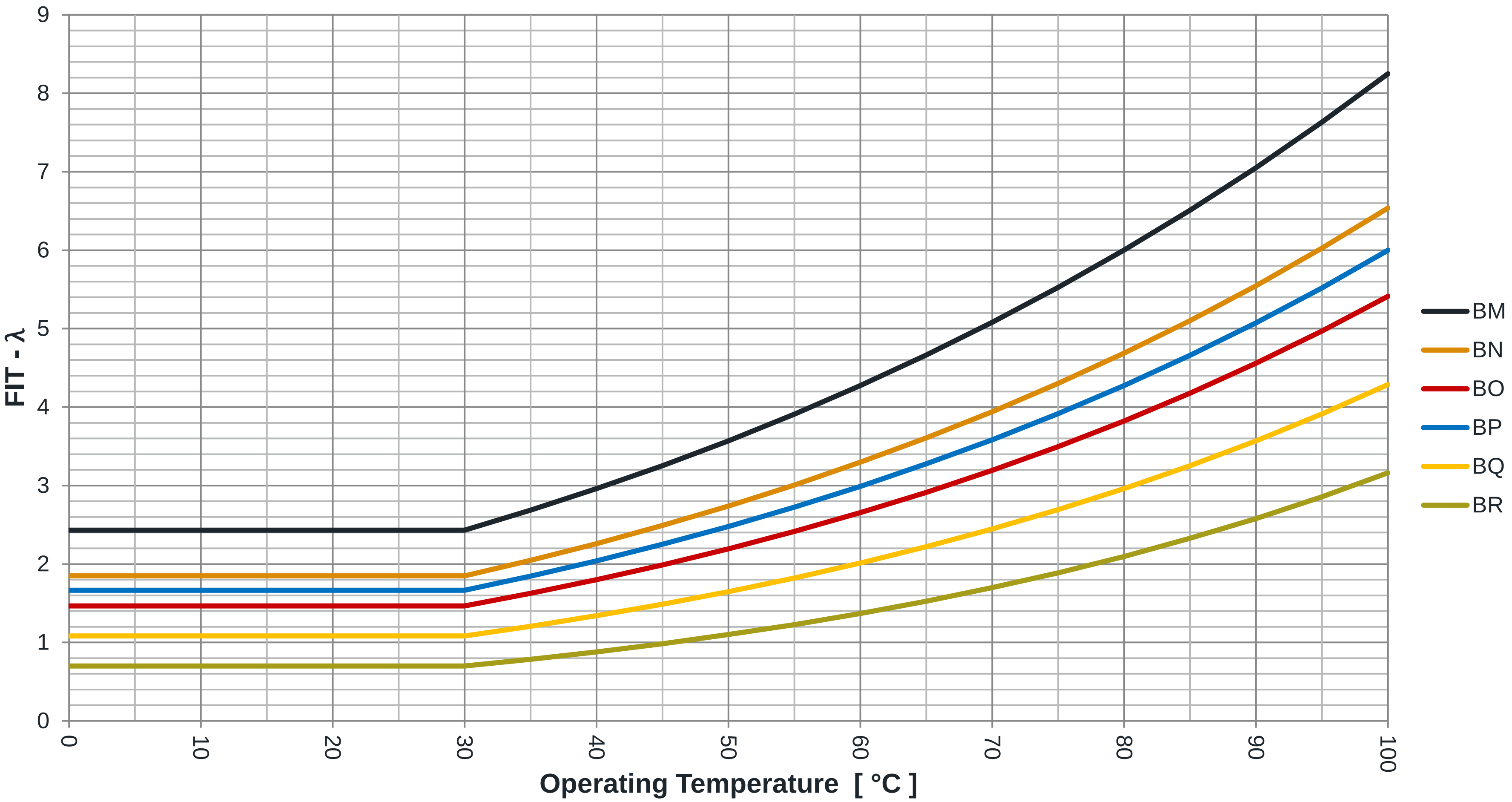
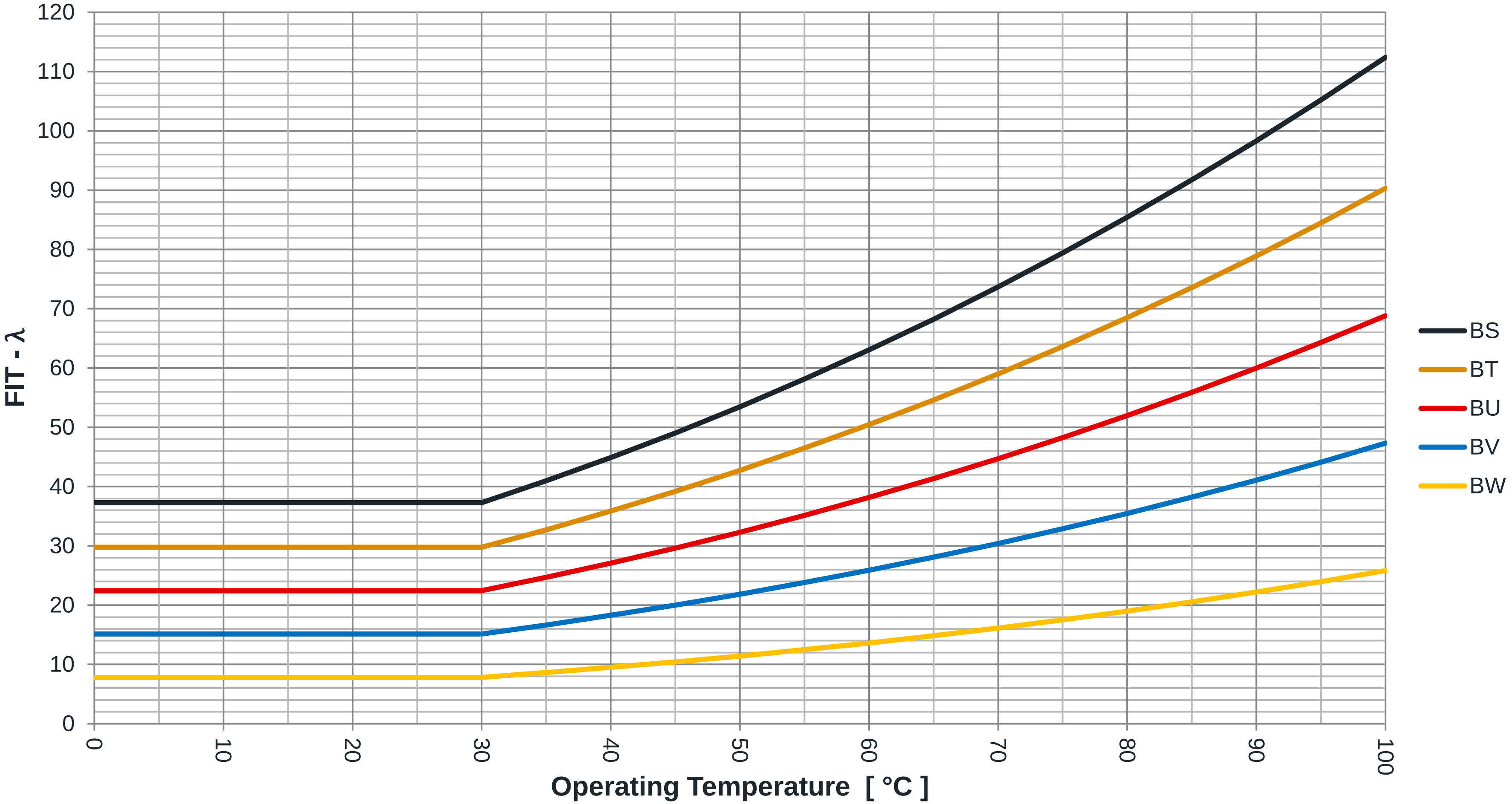
5.10 Graph λ-Values



5.11 Graph λ-Values

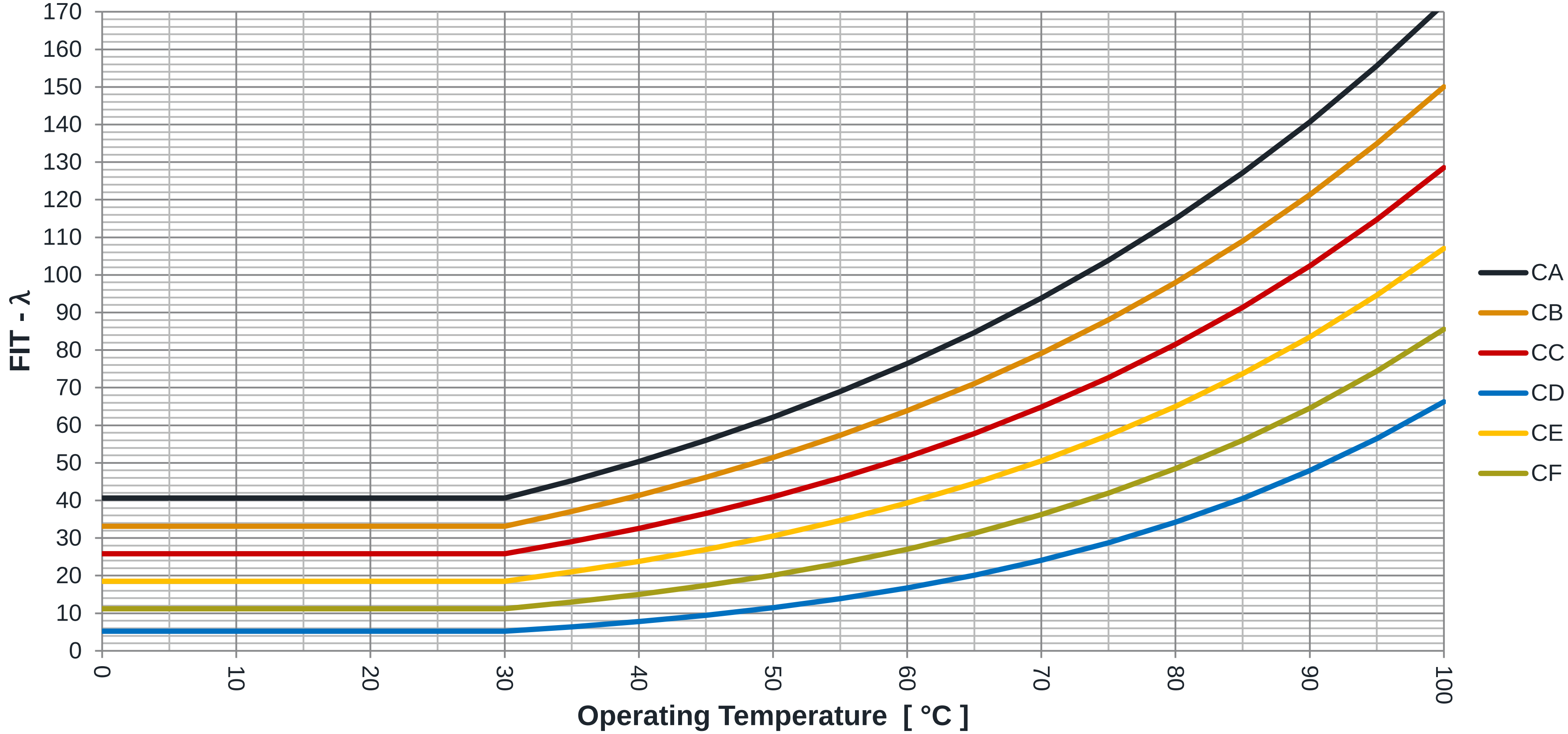


5.12 Graph λ-Values



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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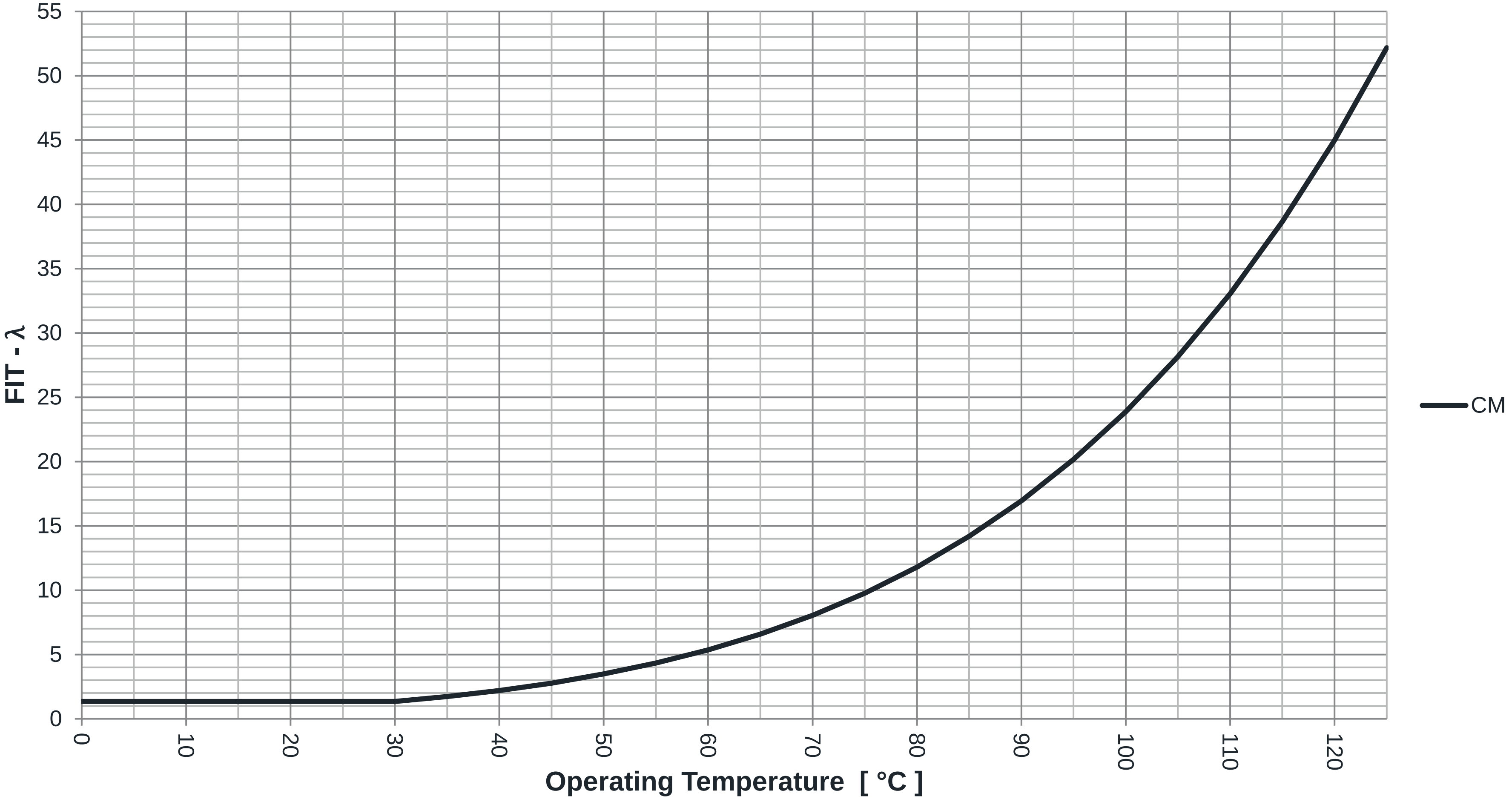
5.15 Graph λ-Values



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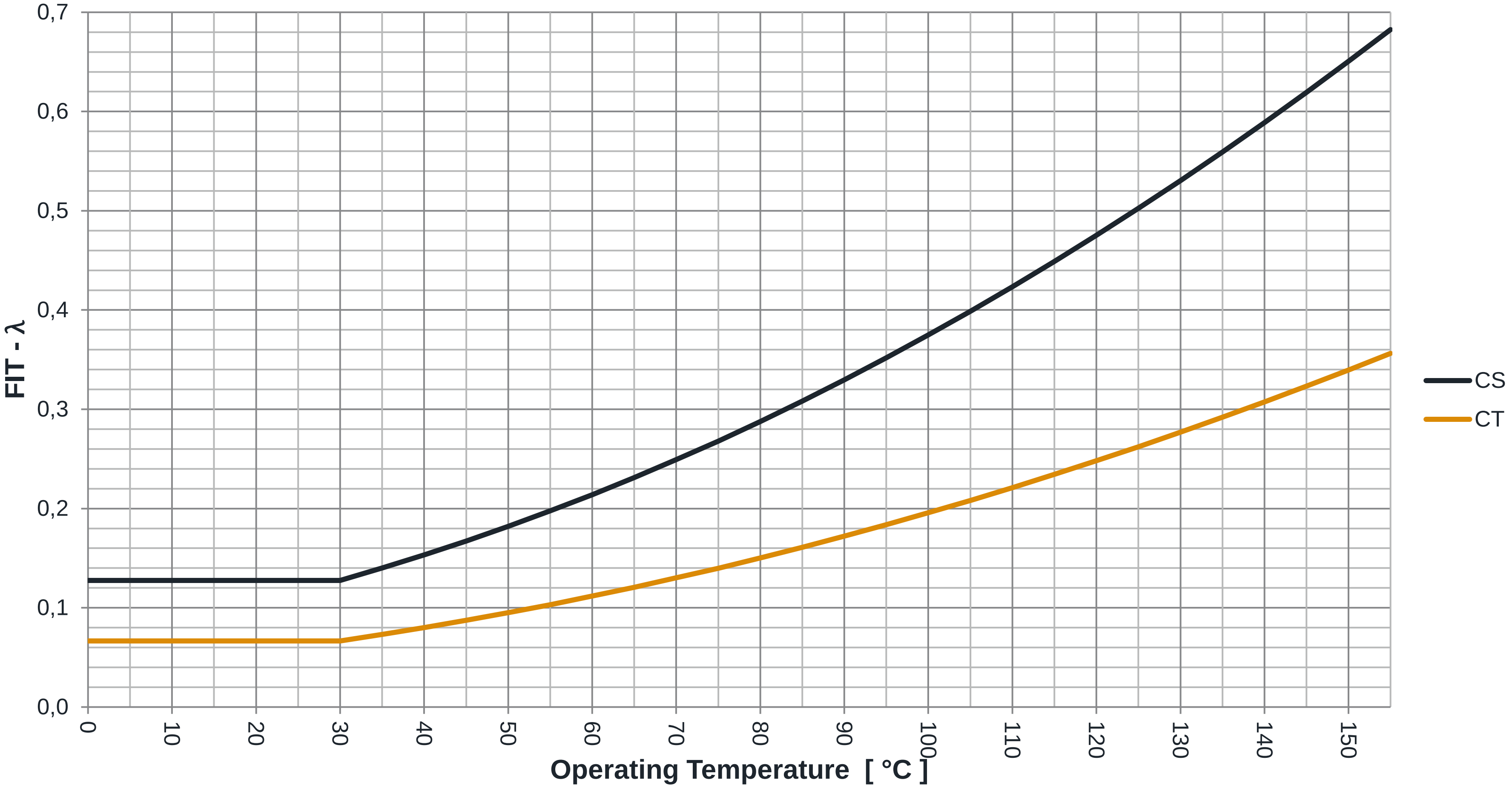
5.16 Graph λ-Values



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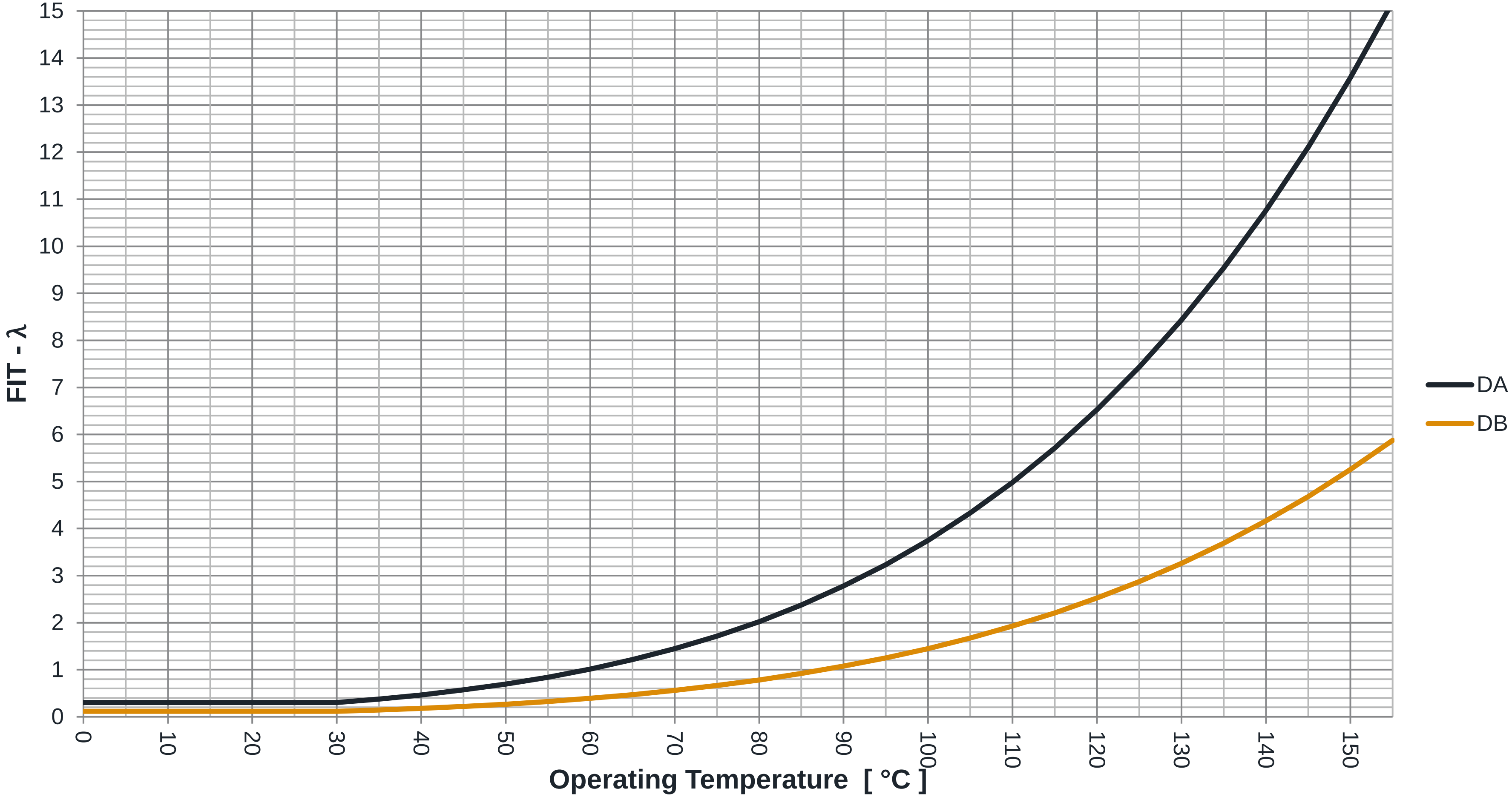
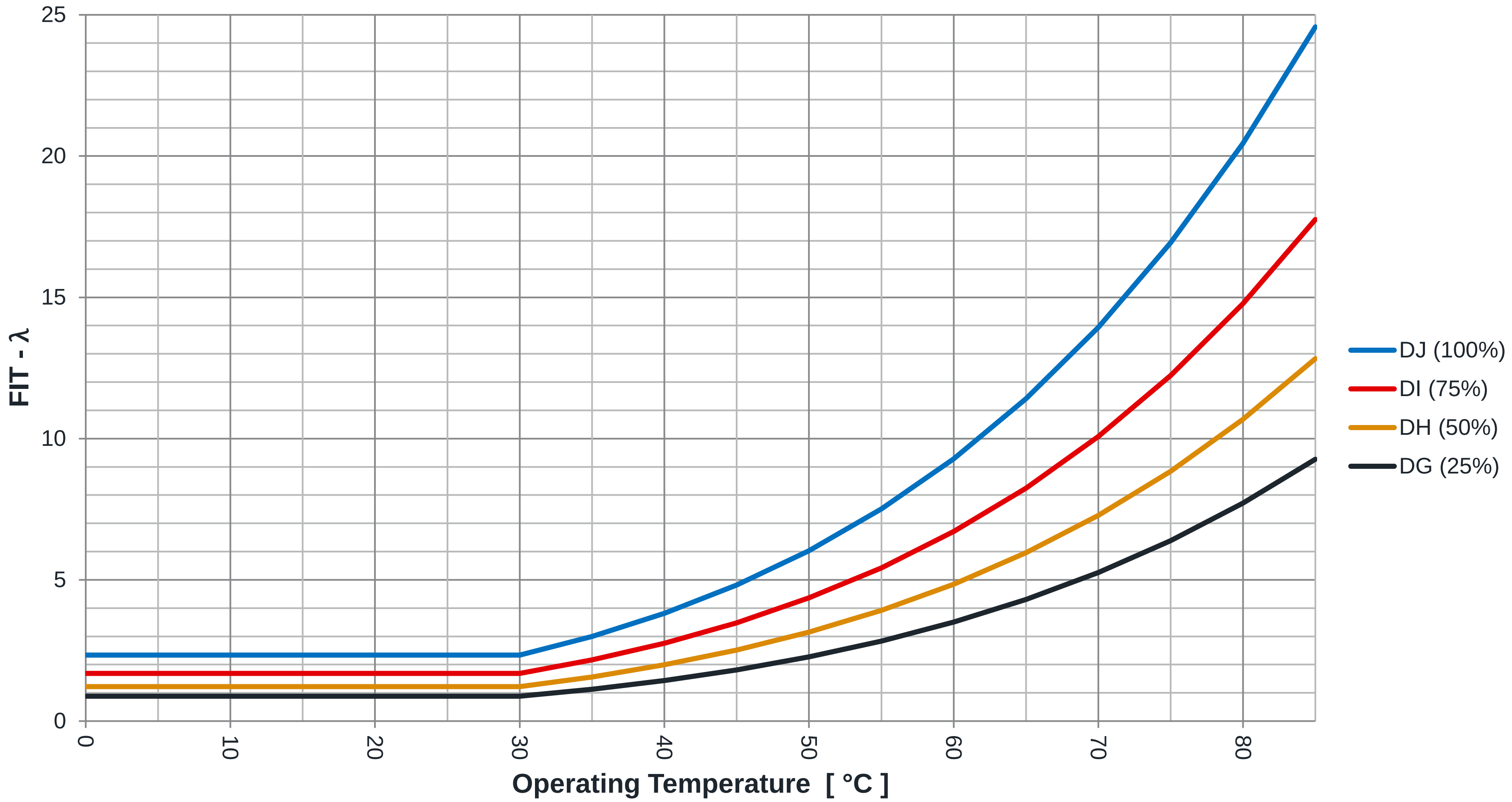
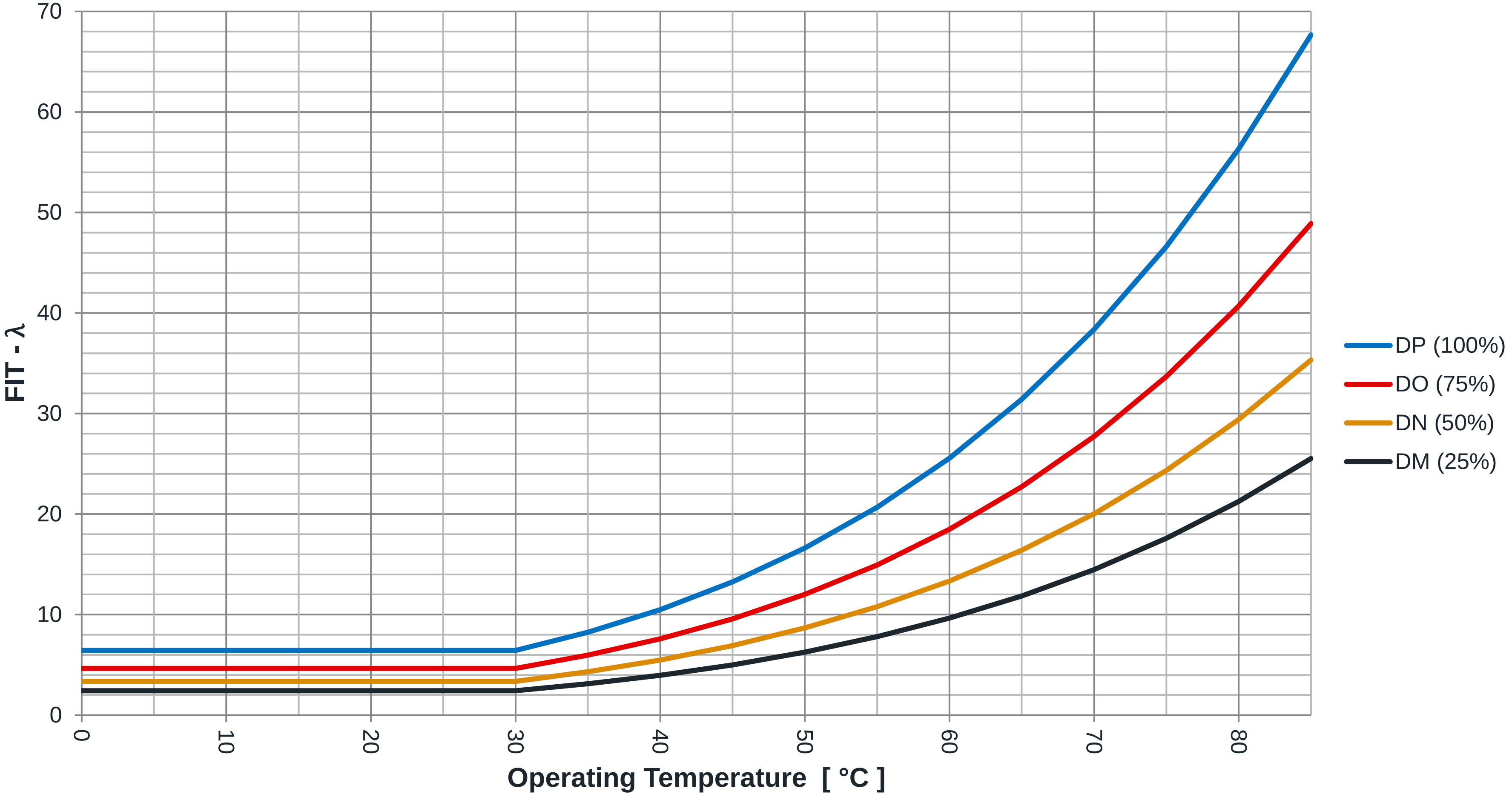
5.17 Graph λ-Values



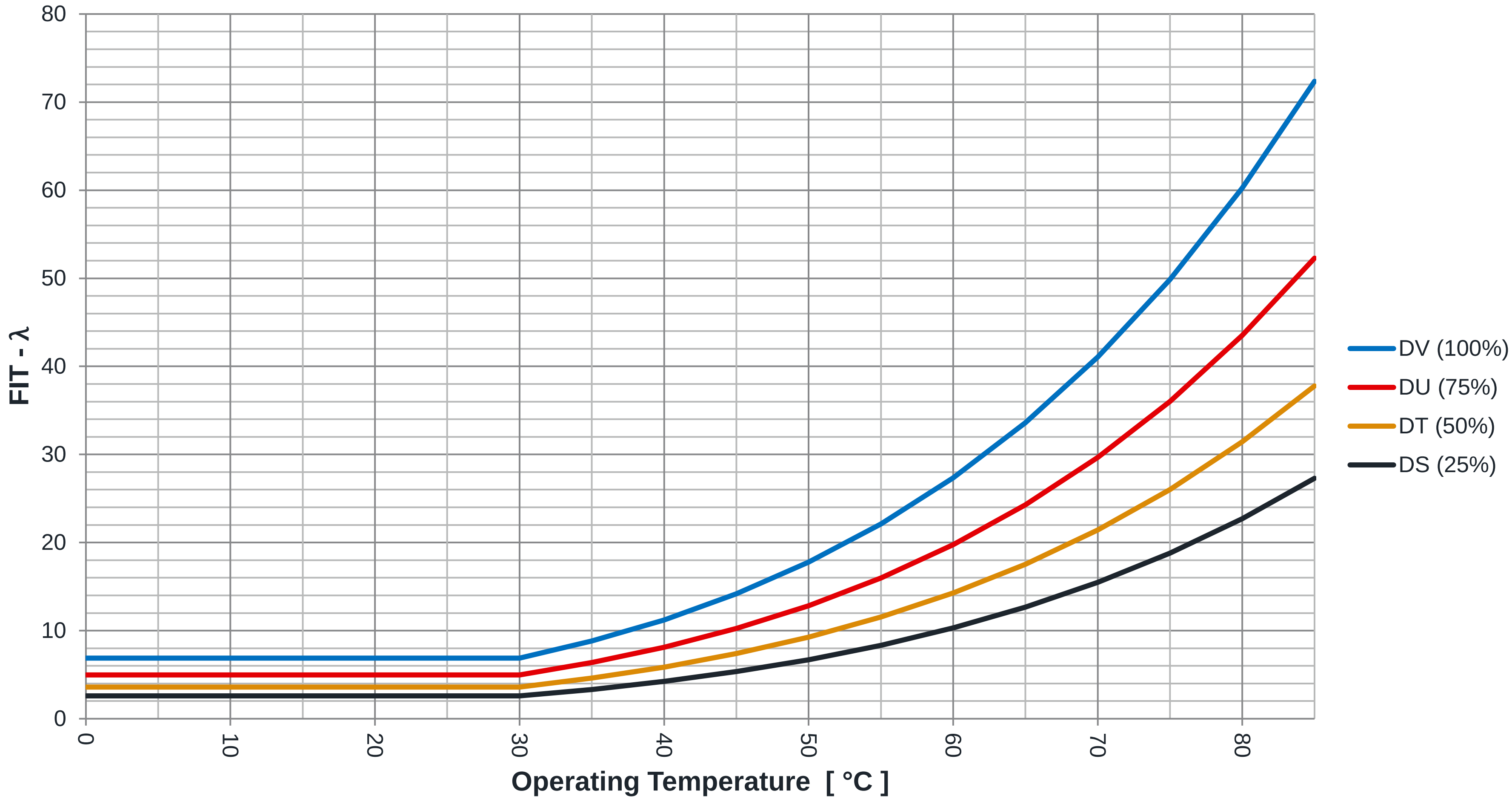
5.18 Graph λ-Values



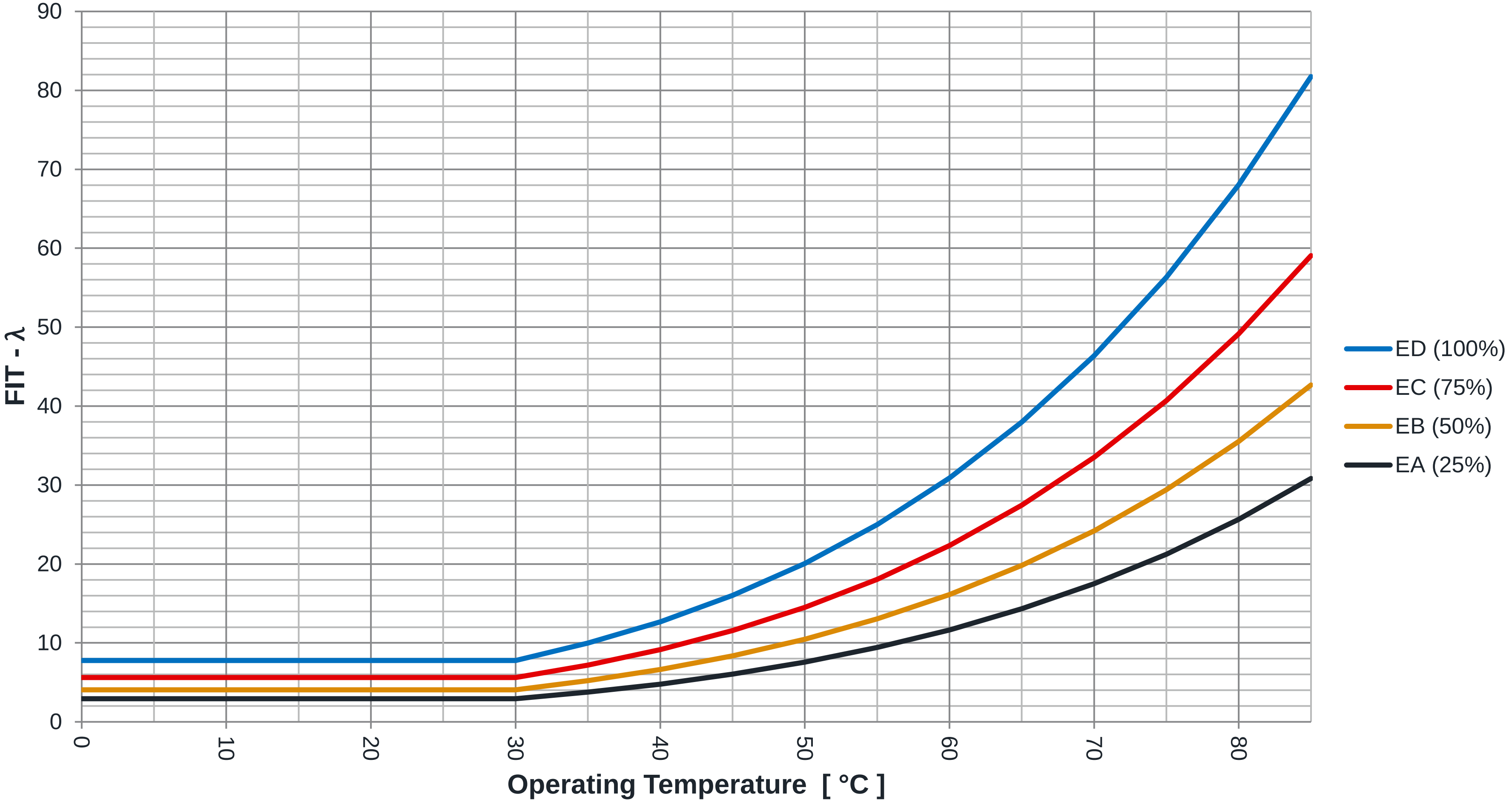
5.19 Graph λ-Values



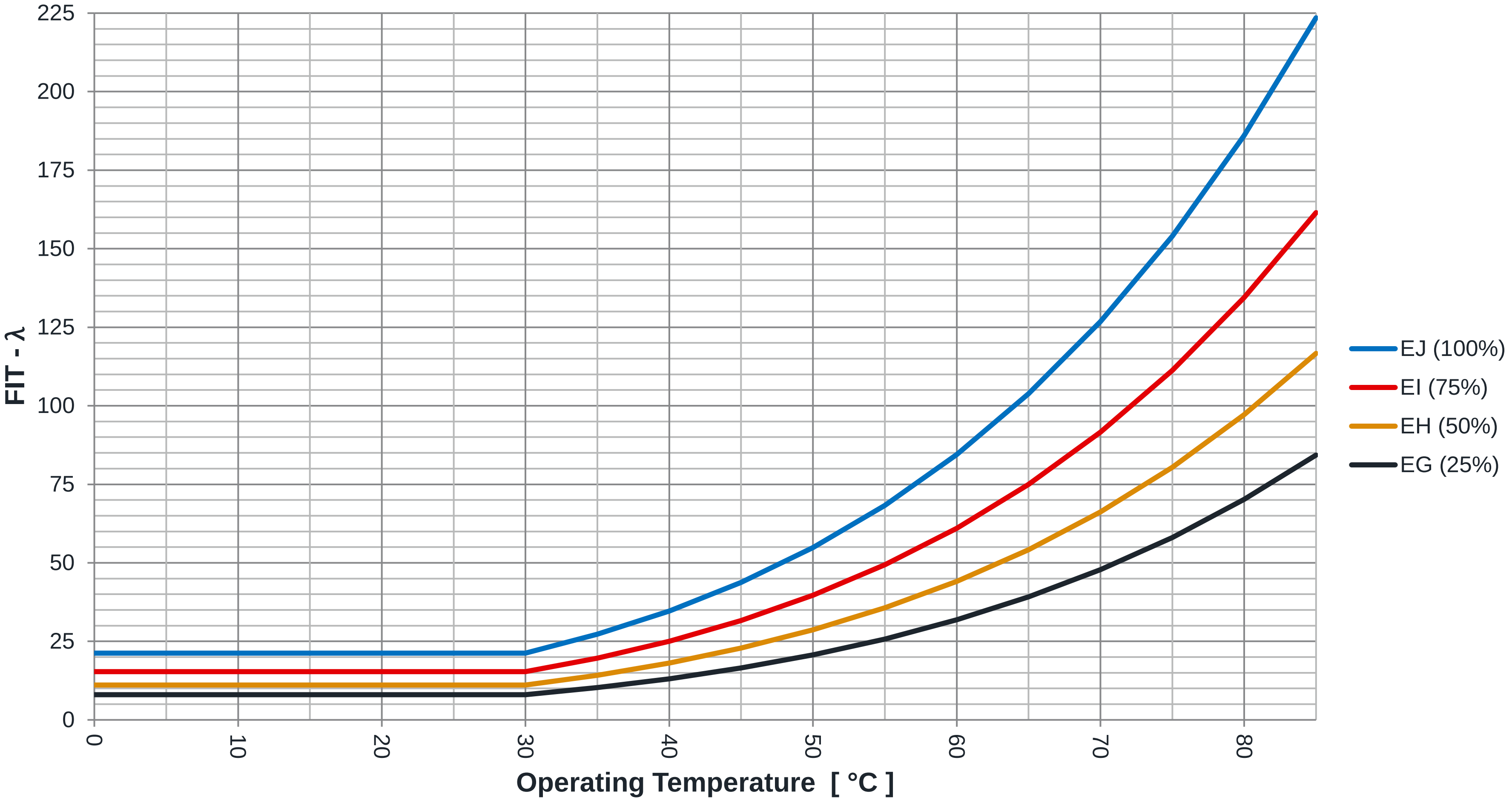
5.20 Graph λ-Values



5.21 Graph λ-Values



5.22 Graph λ-Values



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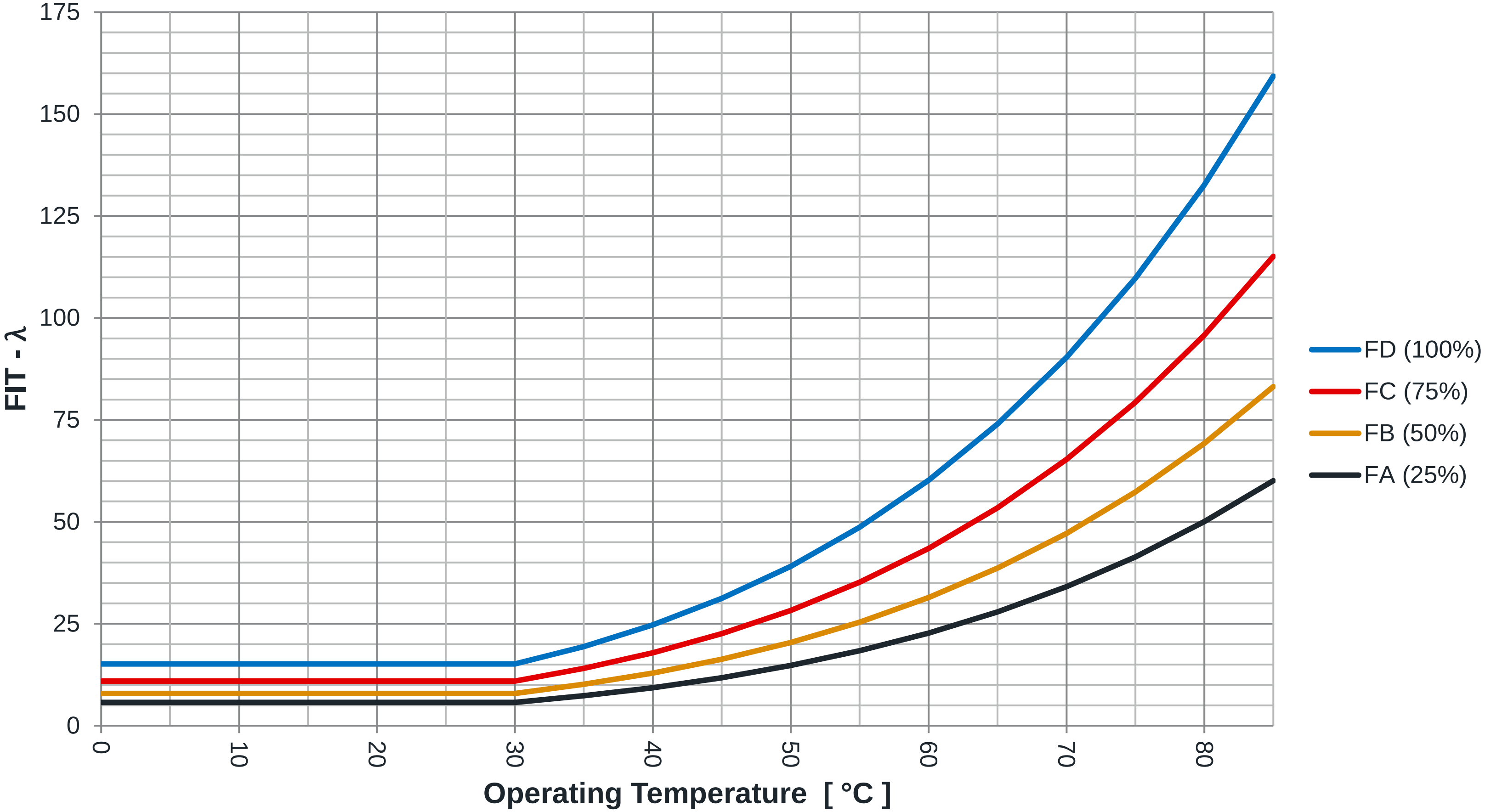
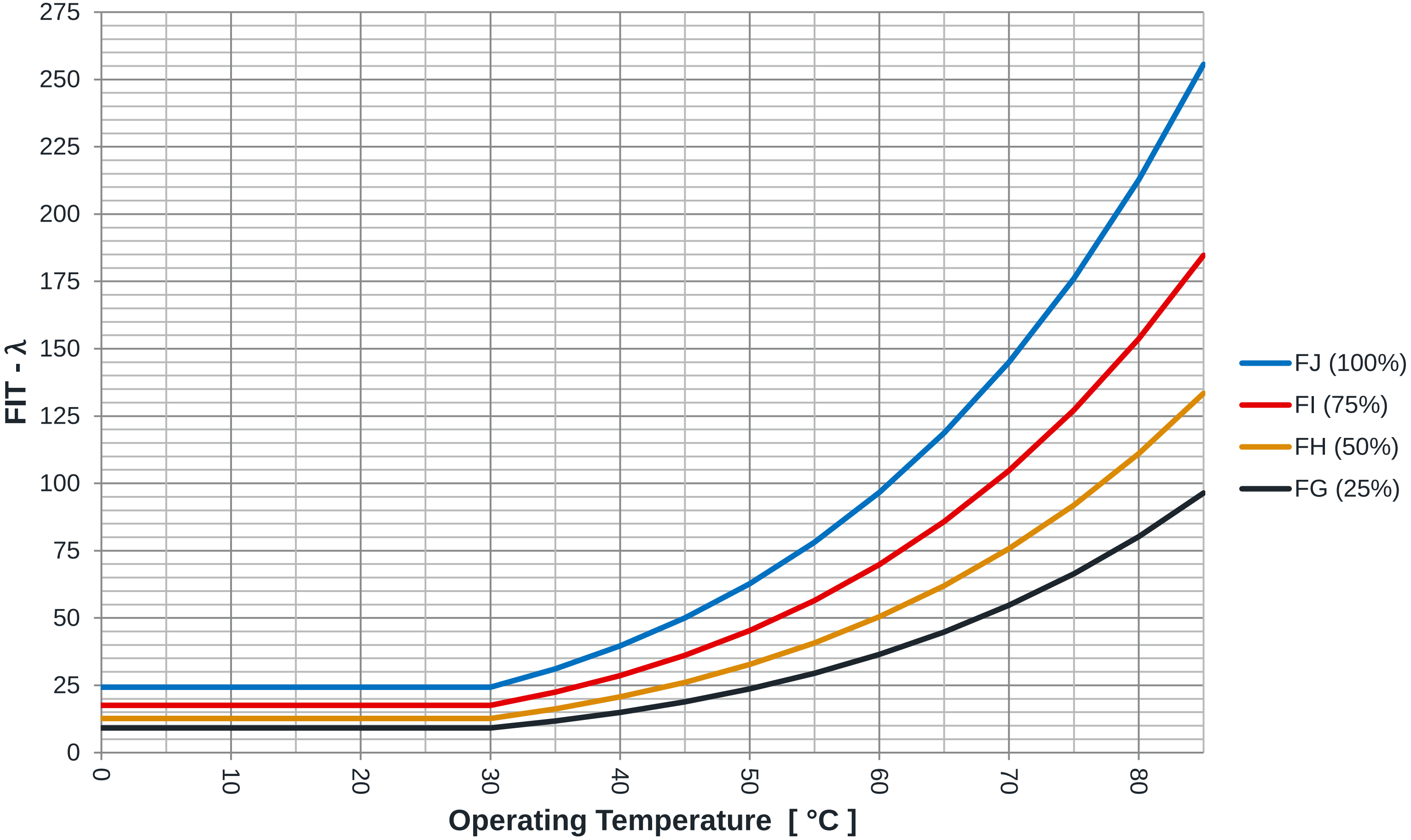
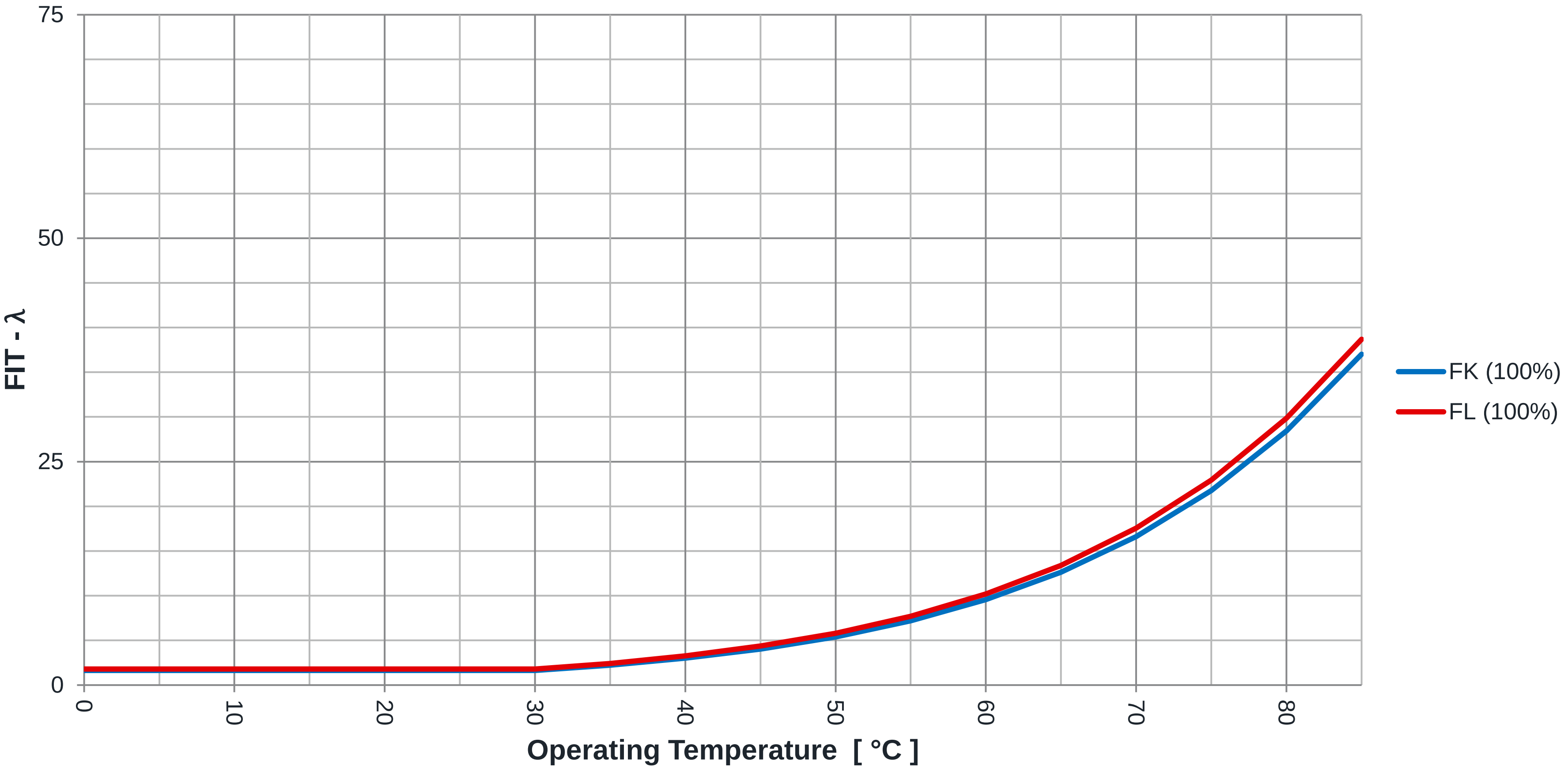
5.23 Graph λ-Values



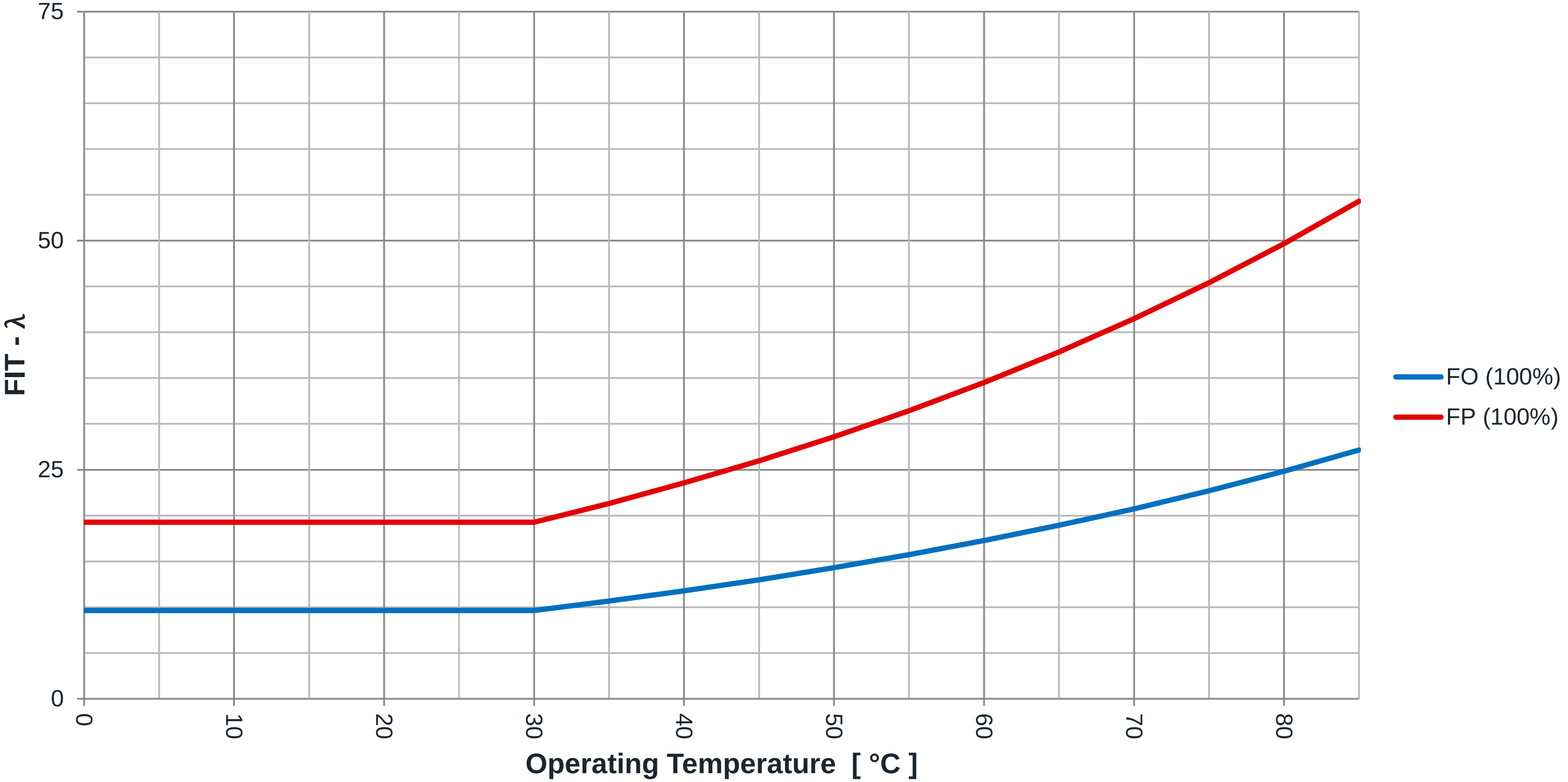
5.24 Graph λ-Values



5.25 Graph λ-Values



5.26 Graph λ-Values



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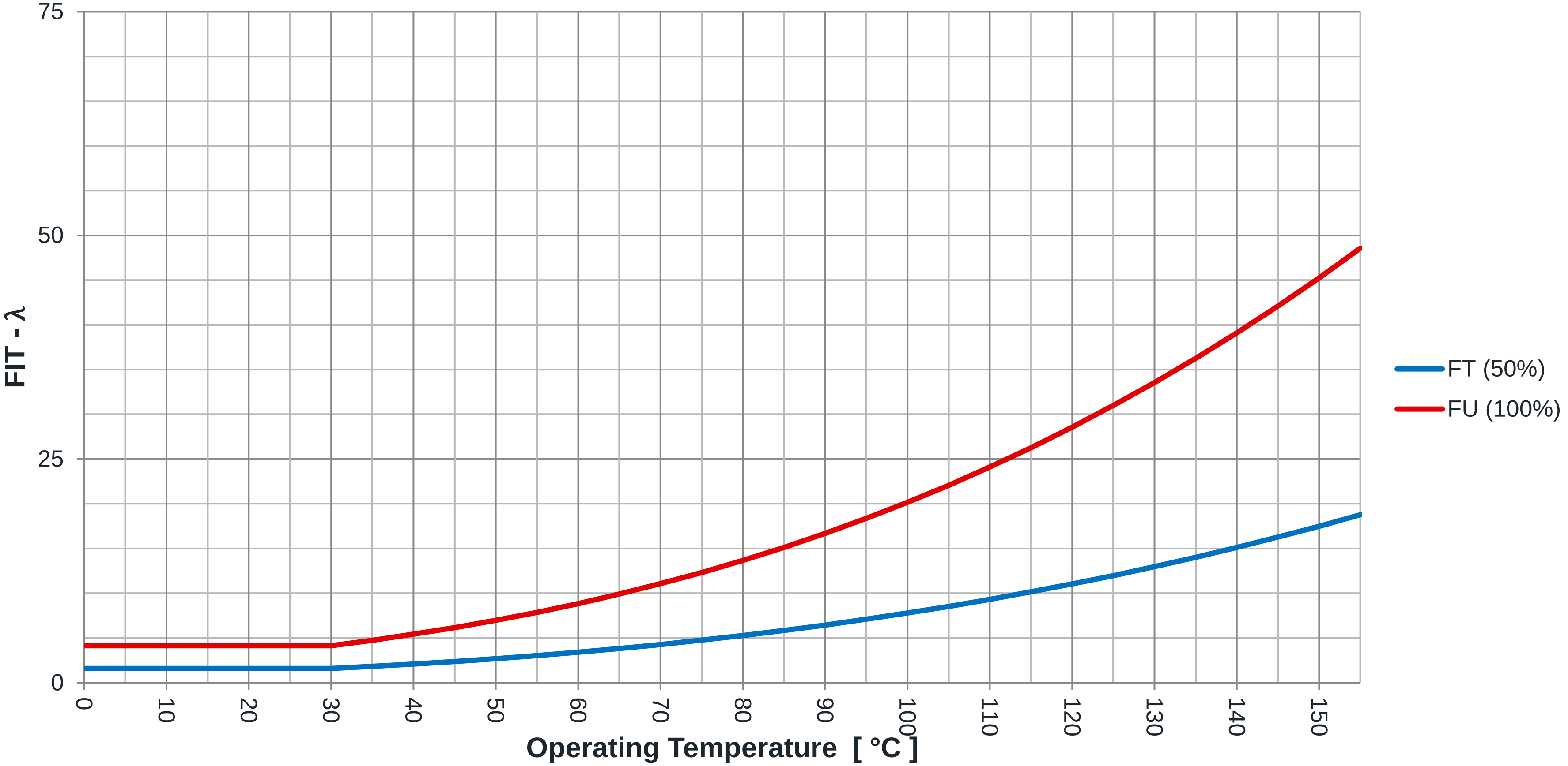
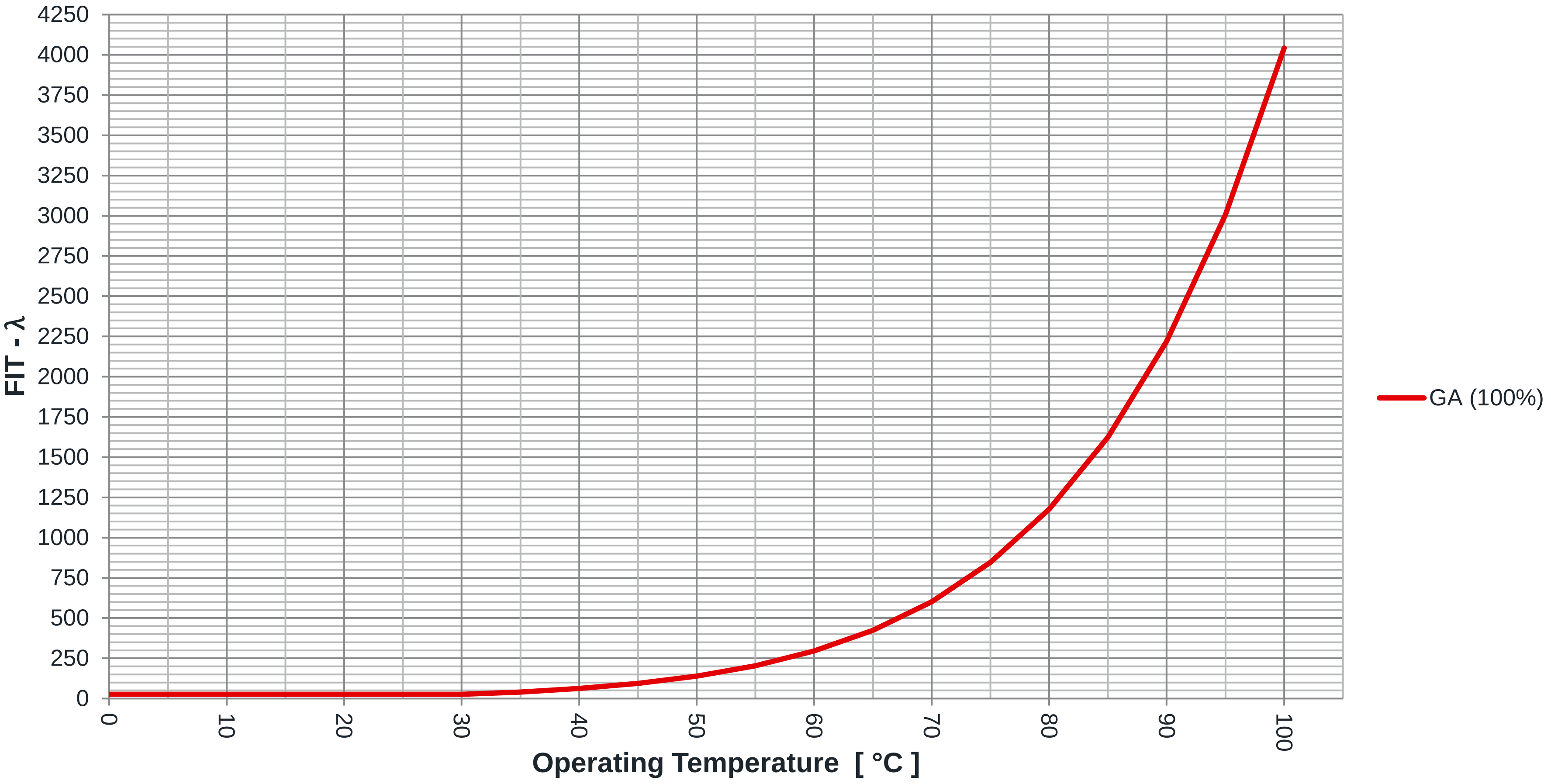
5.27 Graph λ-Values



5.28 Graph λ-Values



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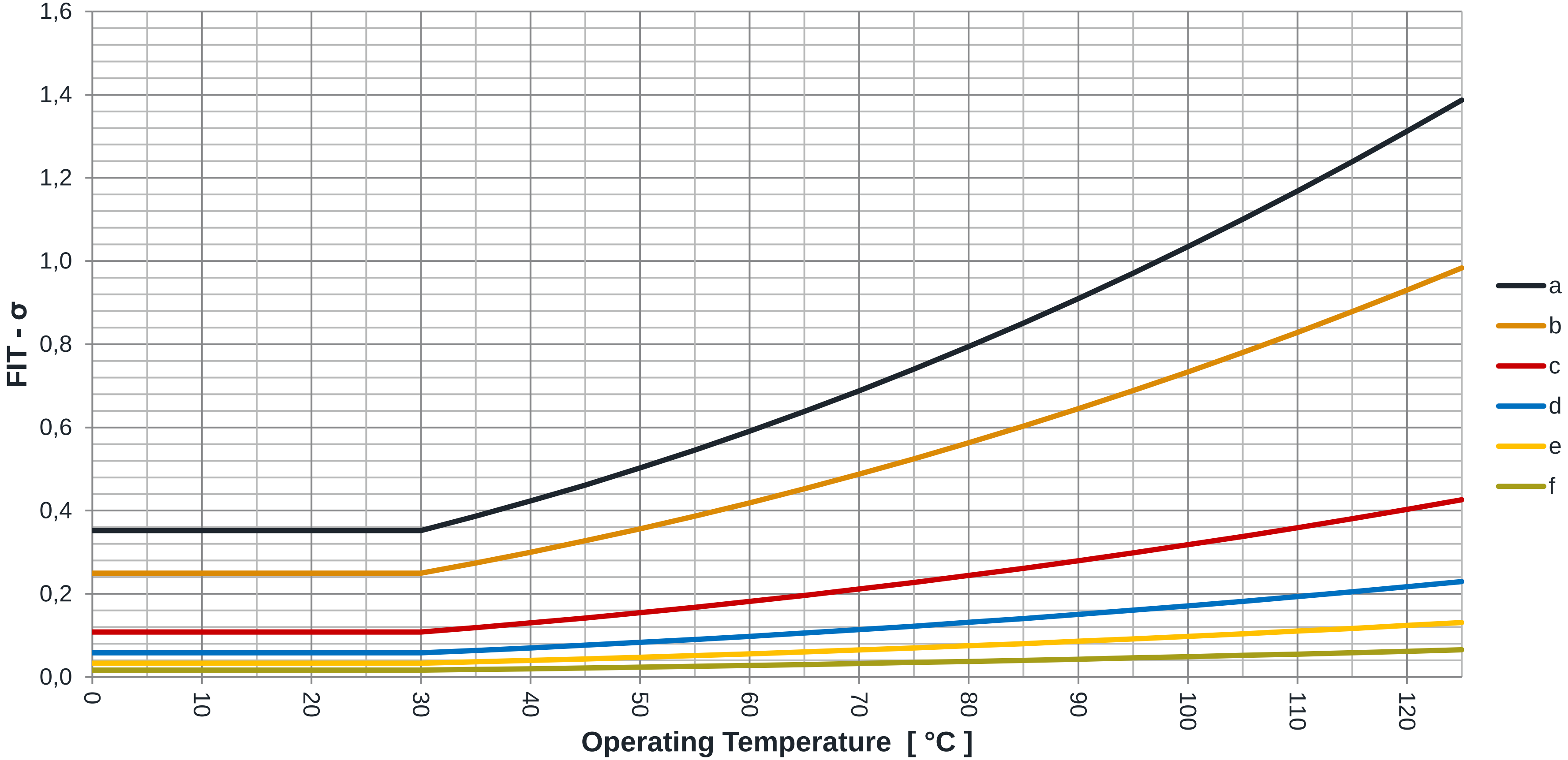
6 σ Graphs

6.1 Graph σ-values



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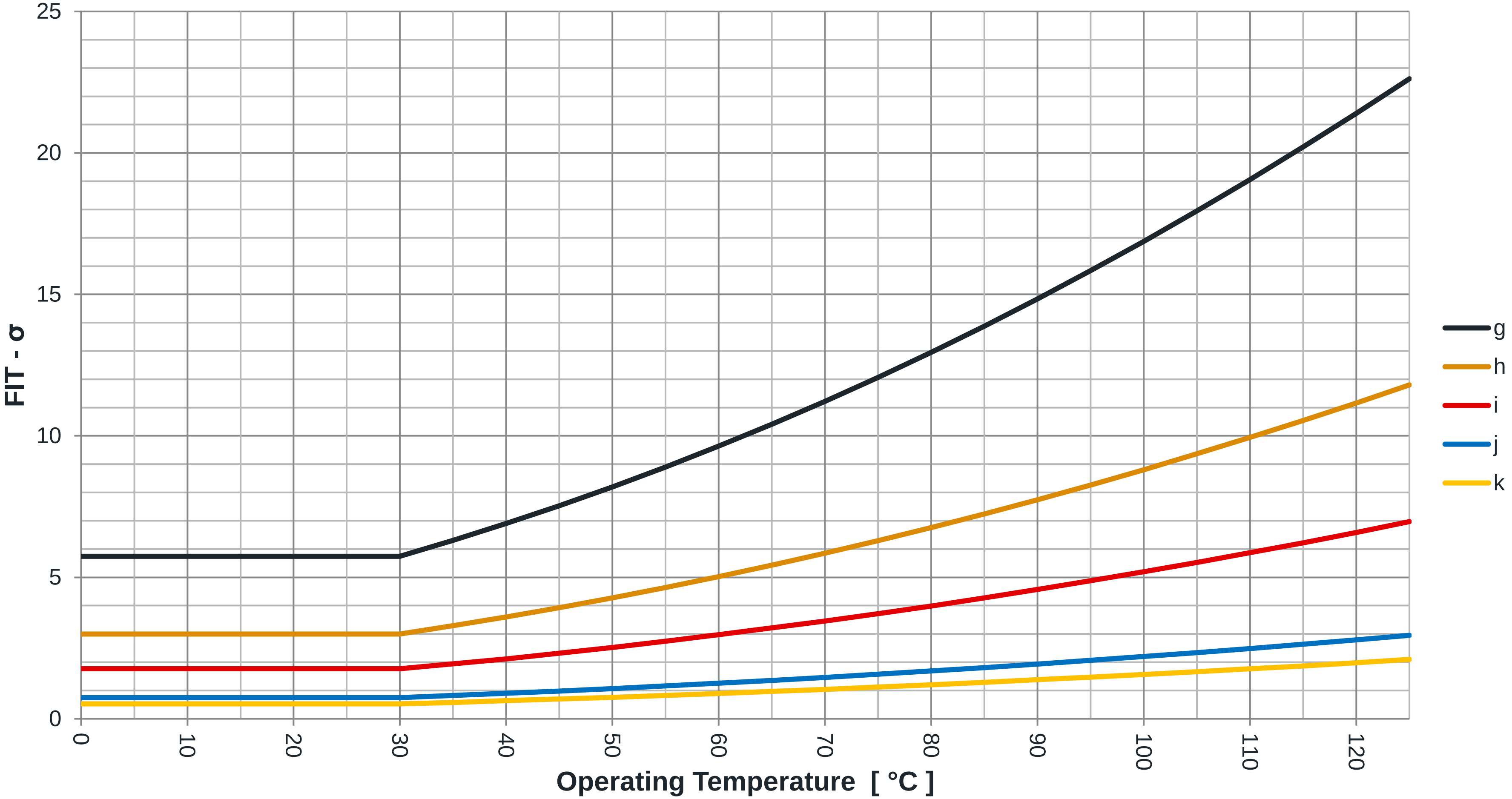
6.2 Graph σ-values



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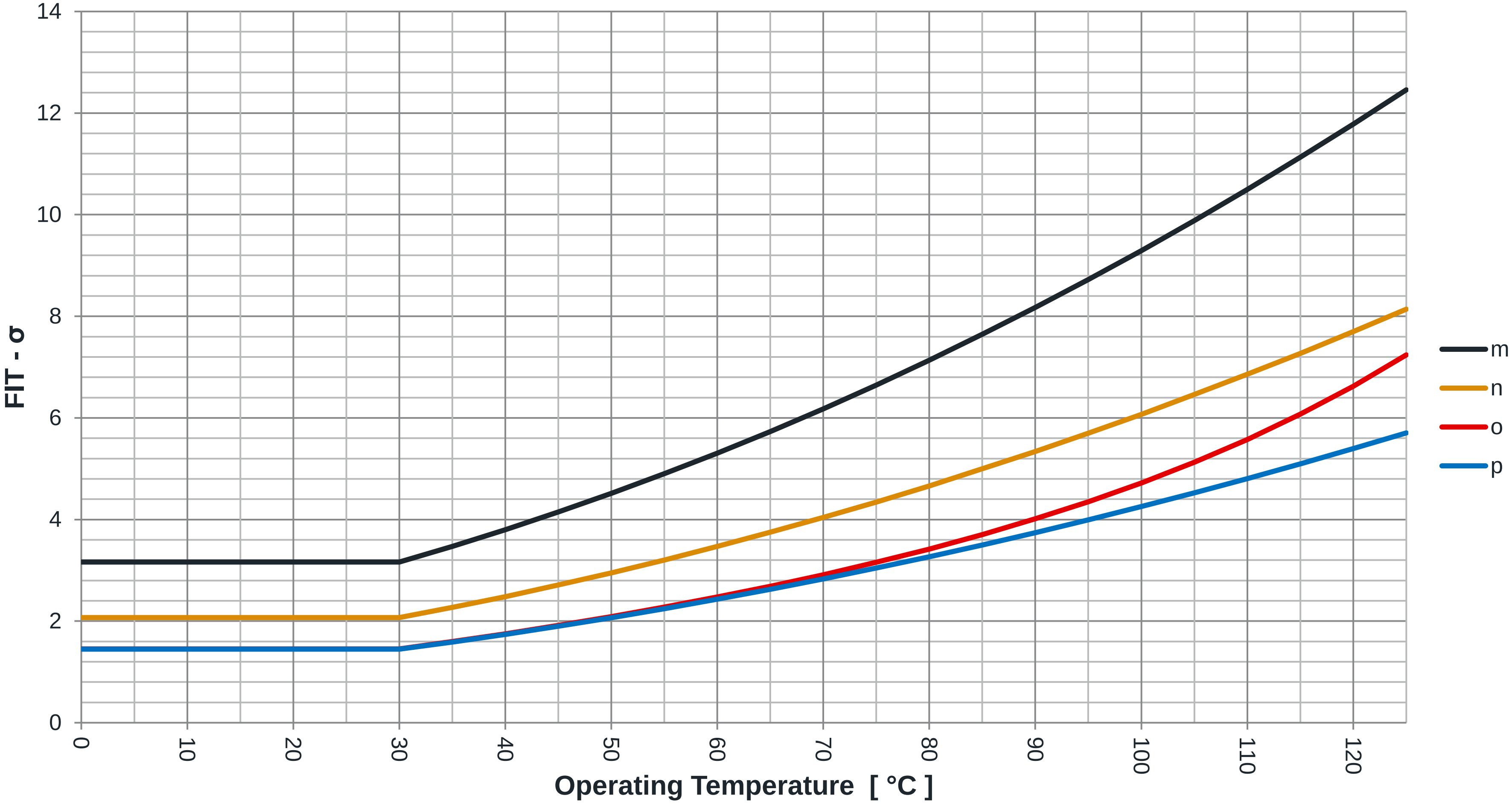
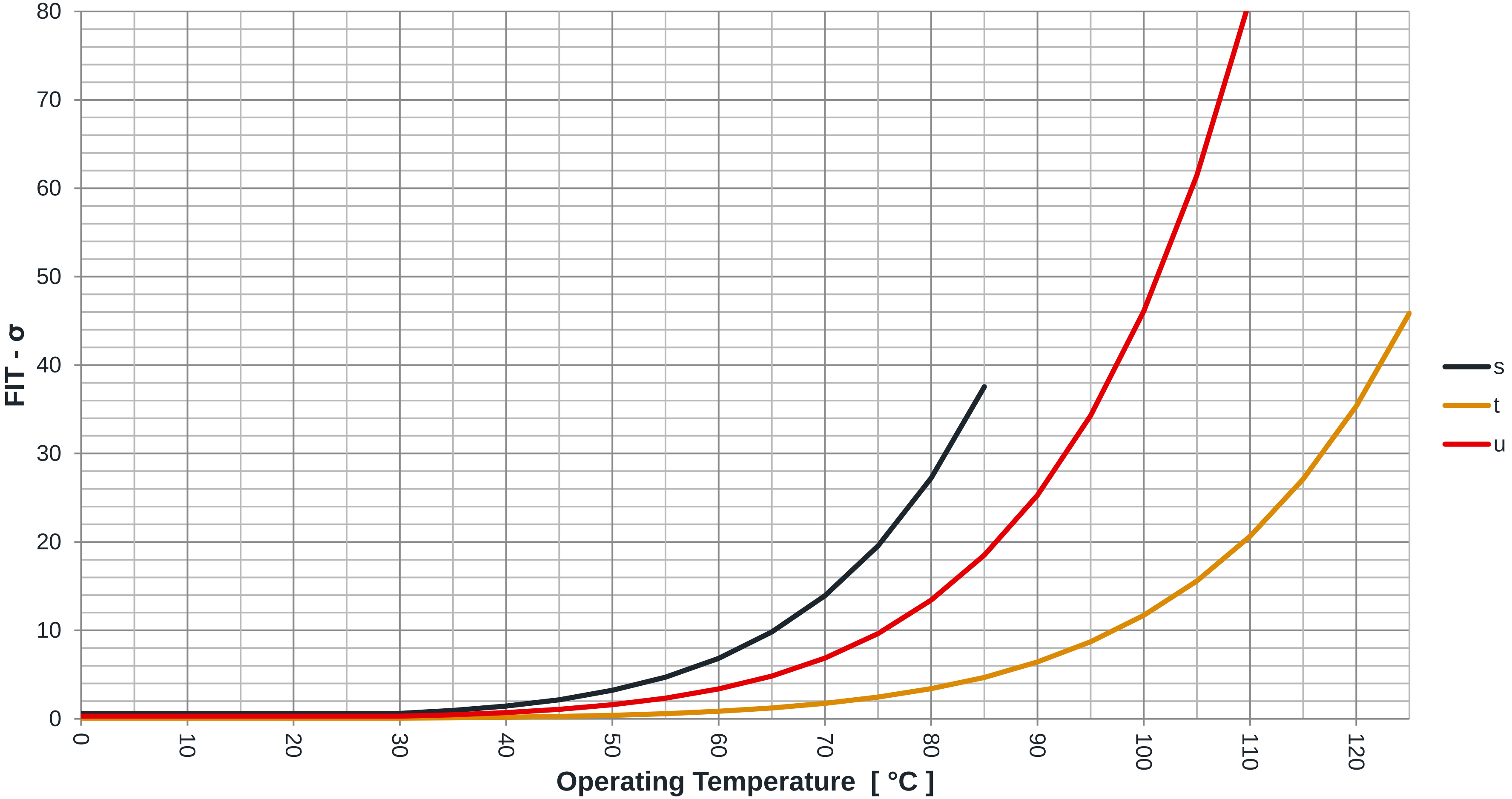
6.3 Graph σ-values



6.4 Graph σ-values



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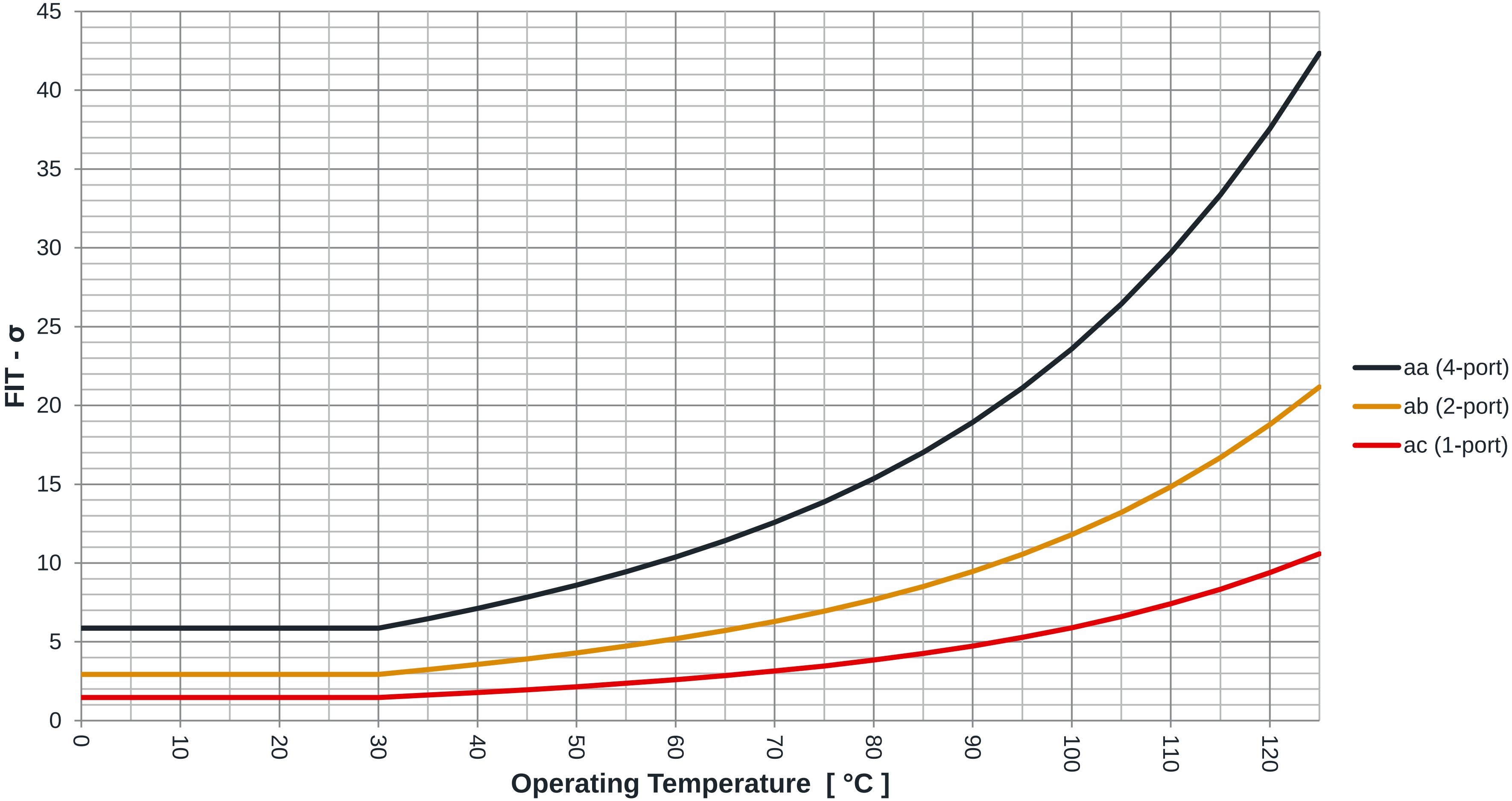
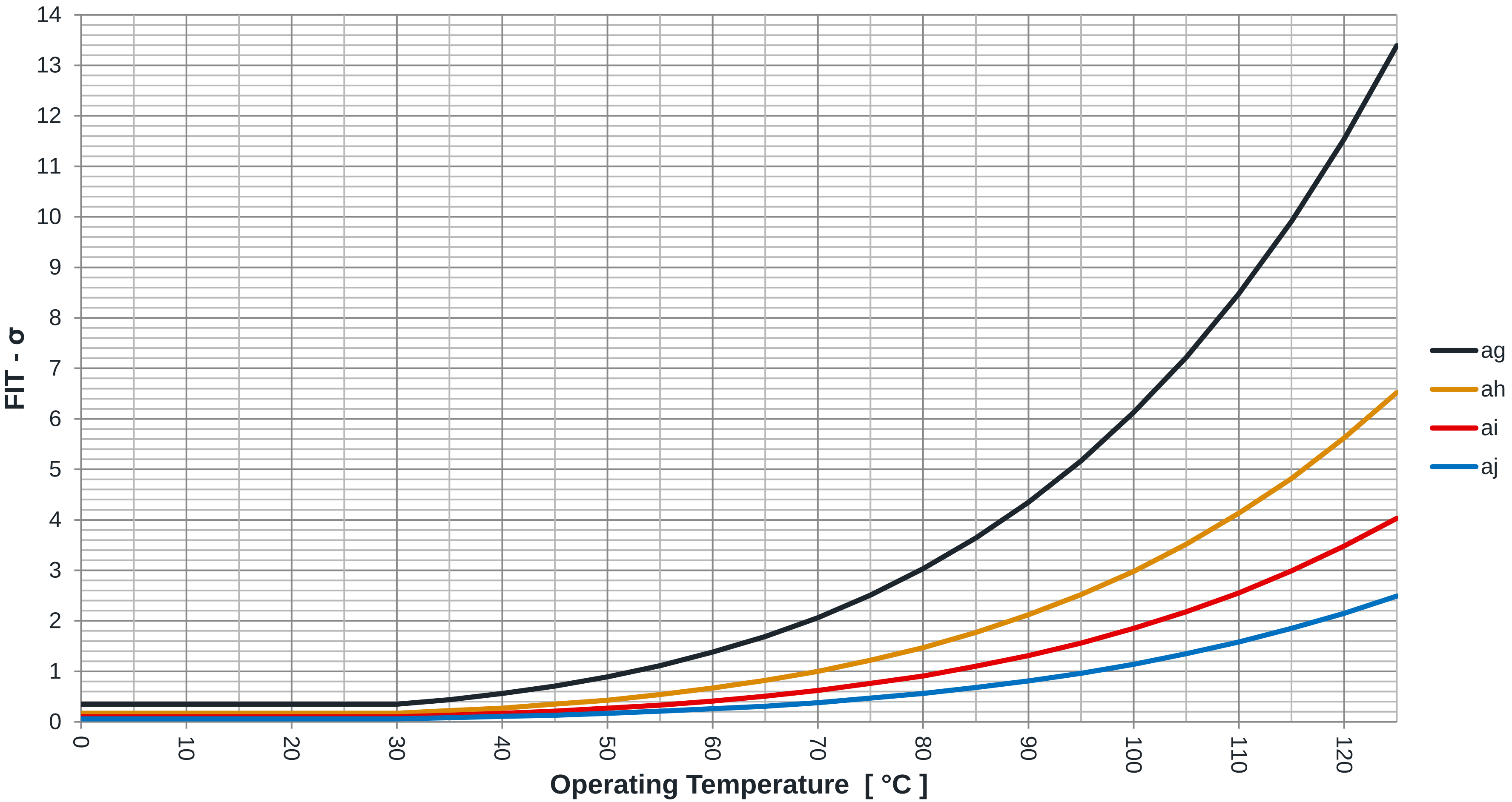
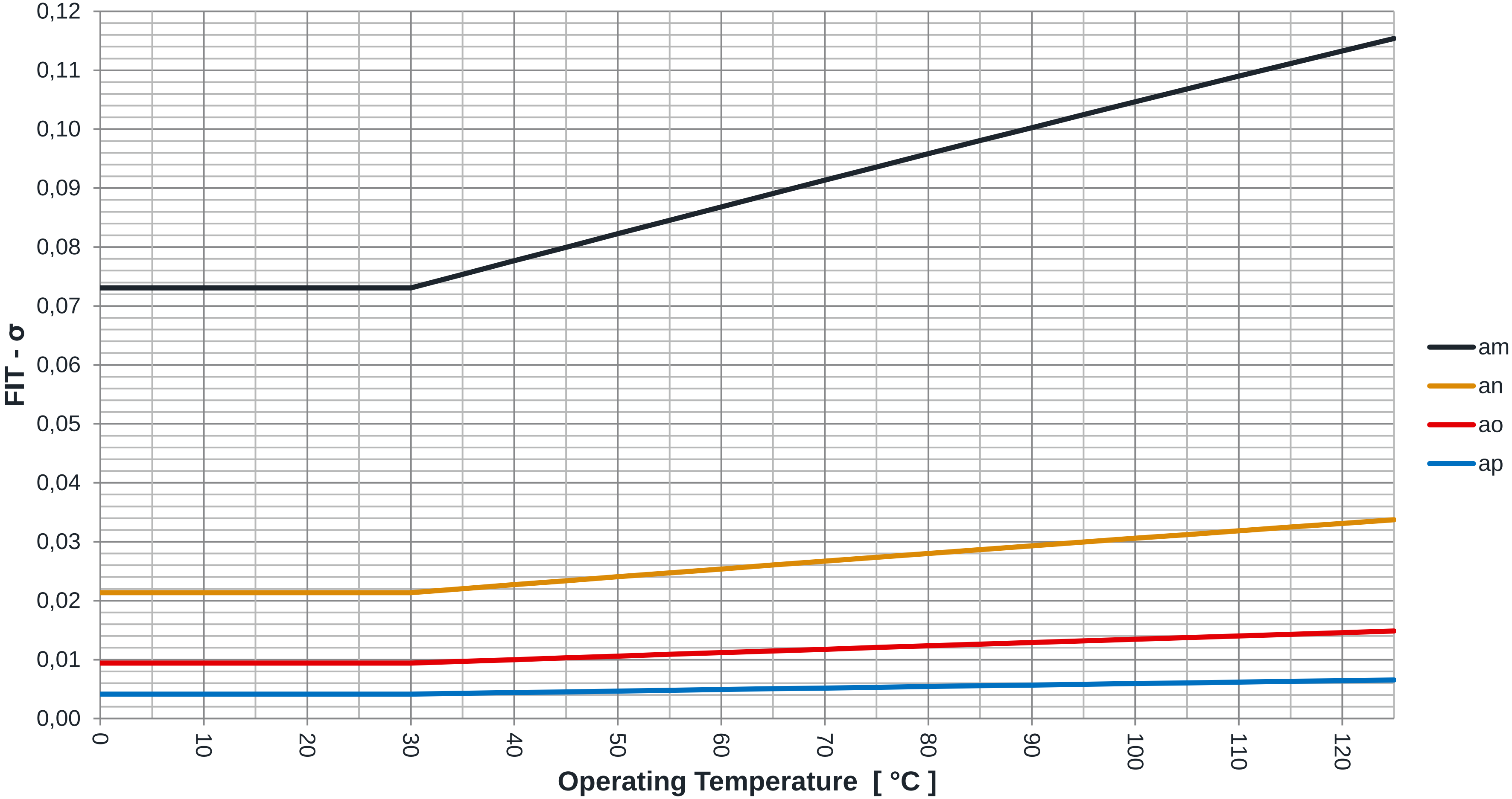
6.5 Graph σ-values



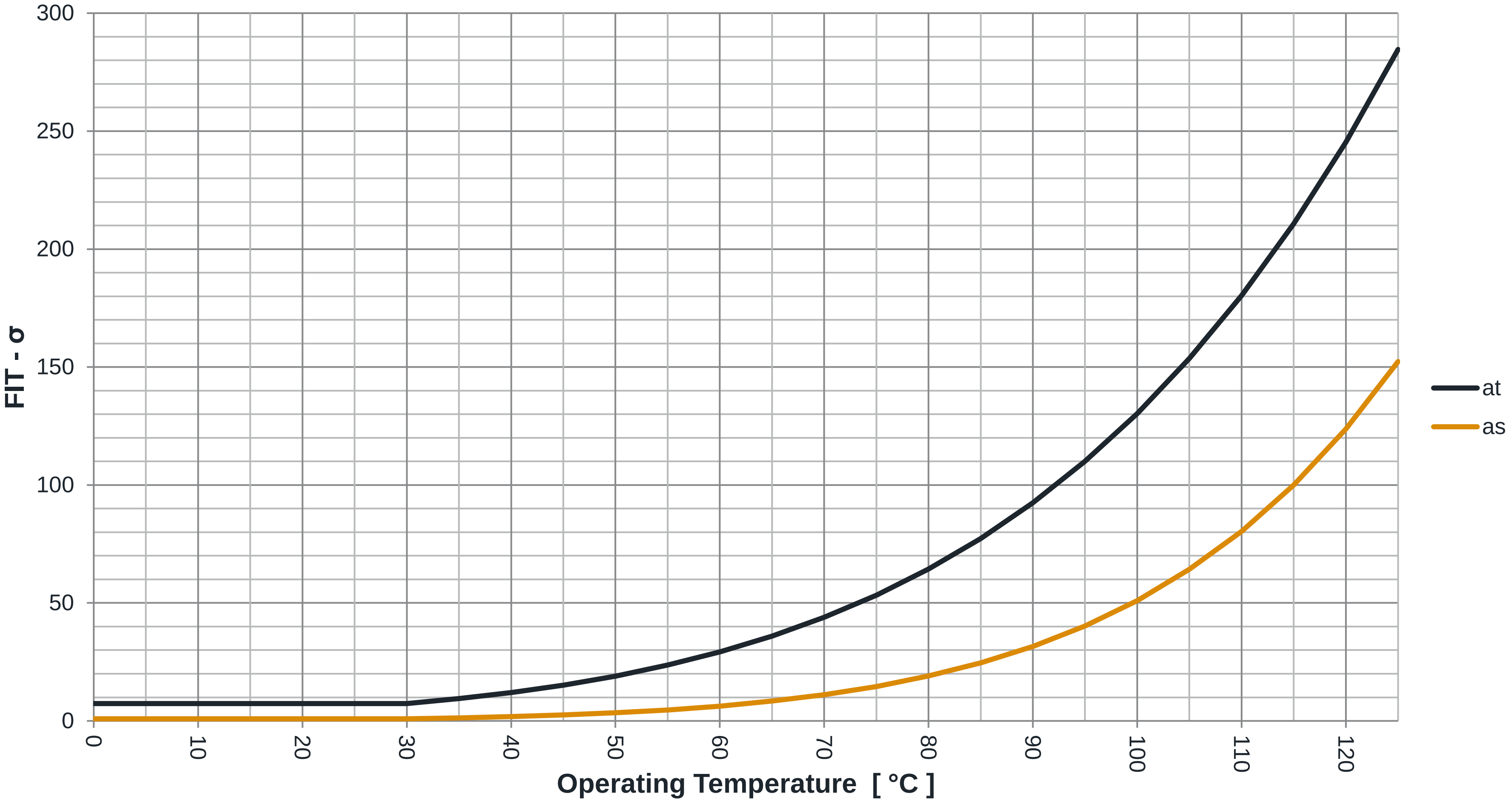
6.6 Graph σ-values



6.7 Graph σ-values



6.8 Graph σ-values



6.9 Graph σ-values

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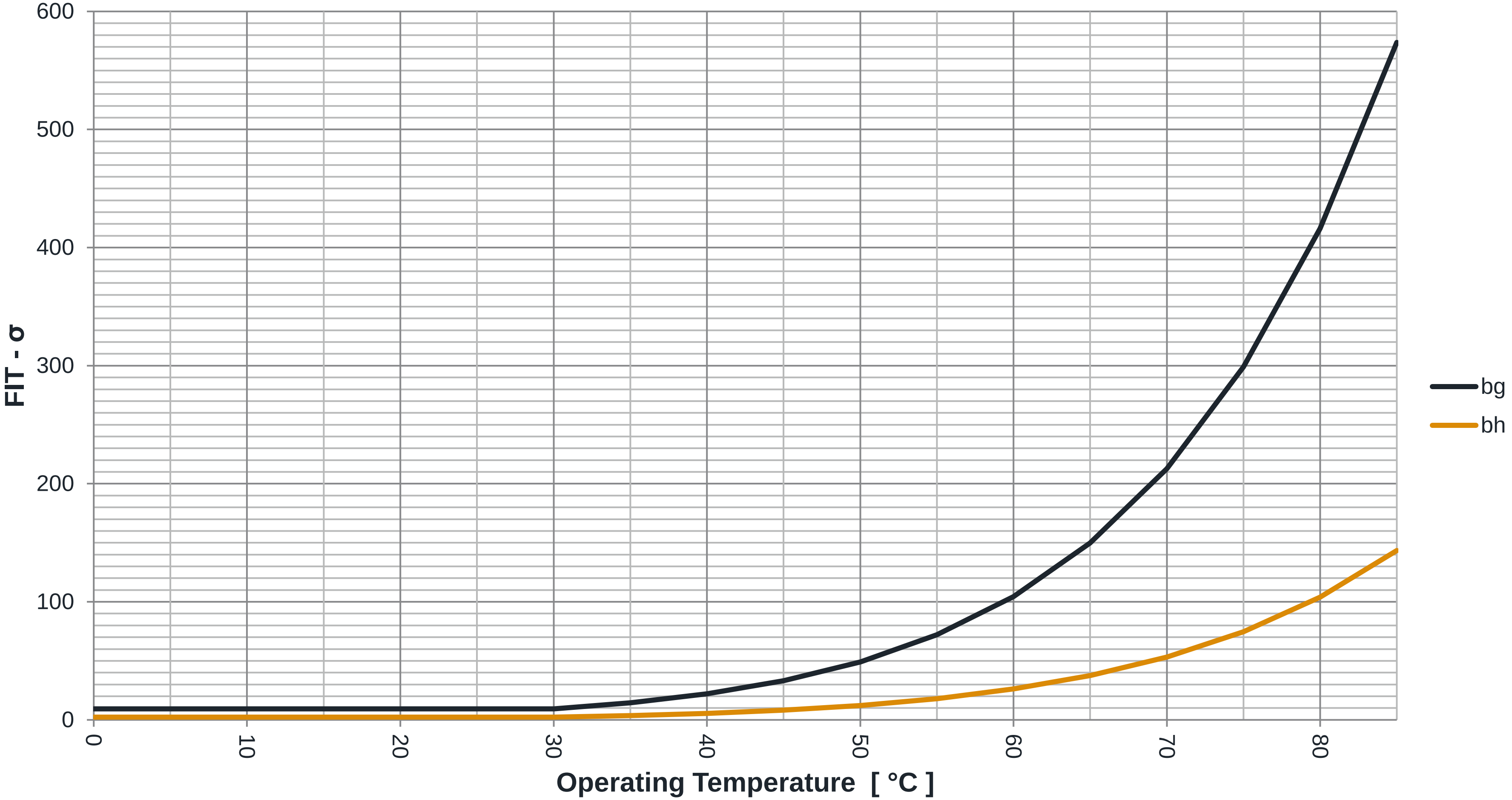
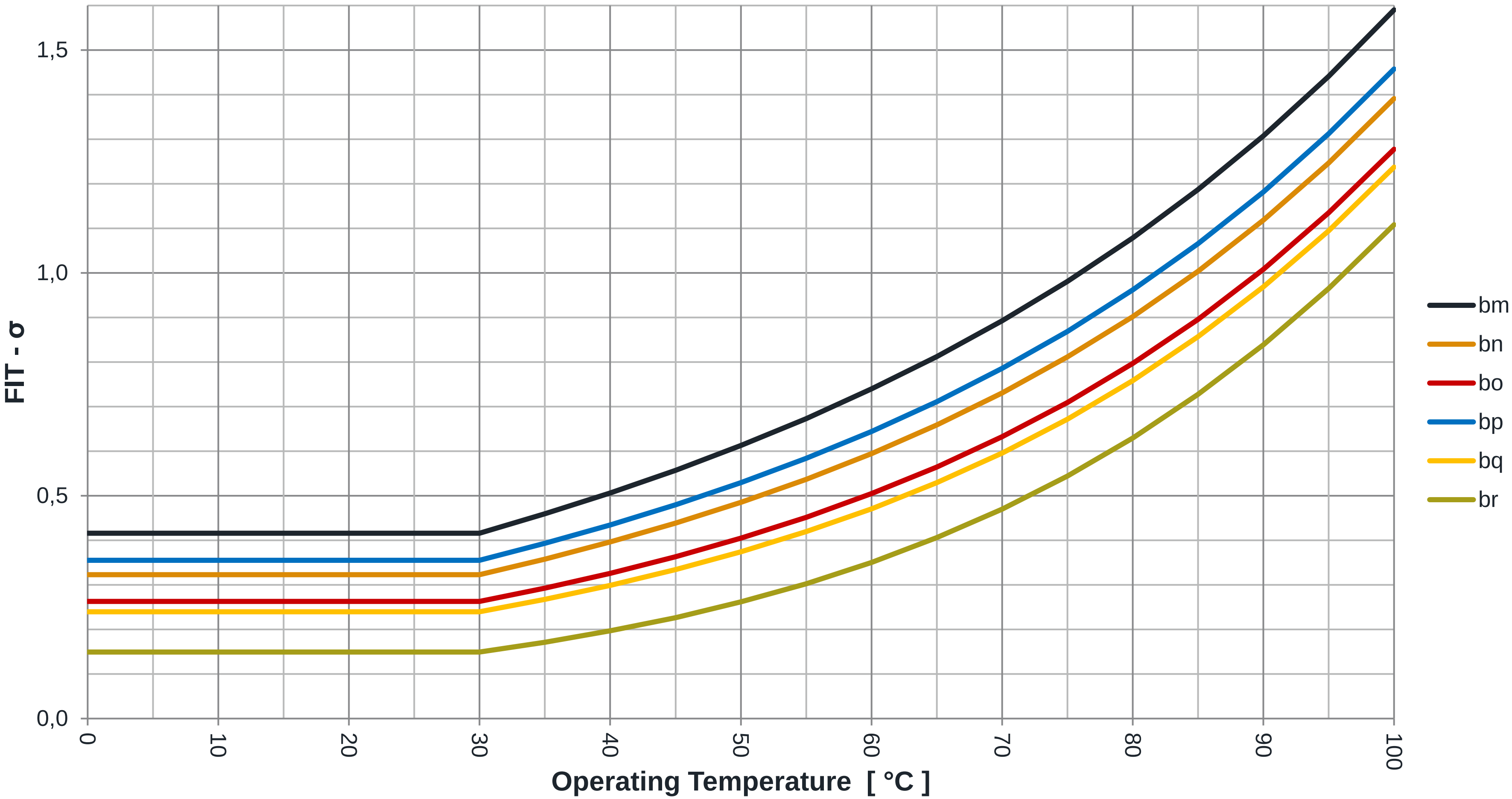
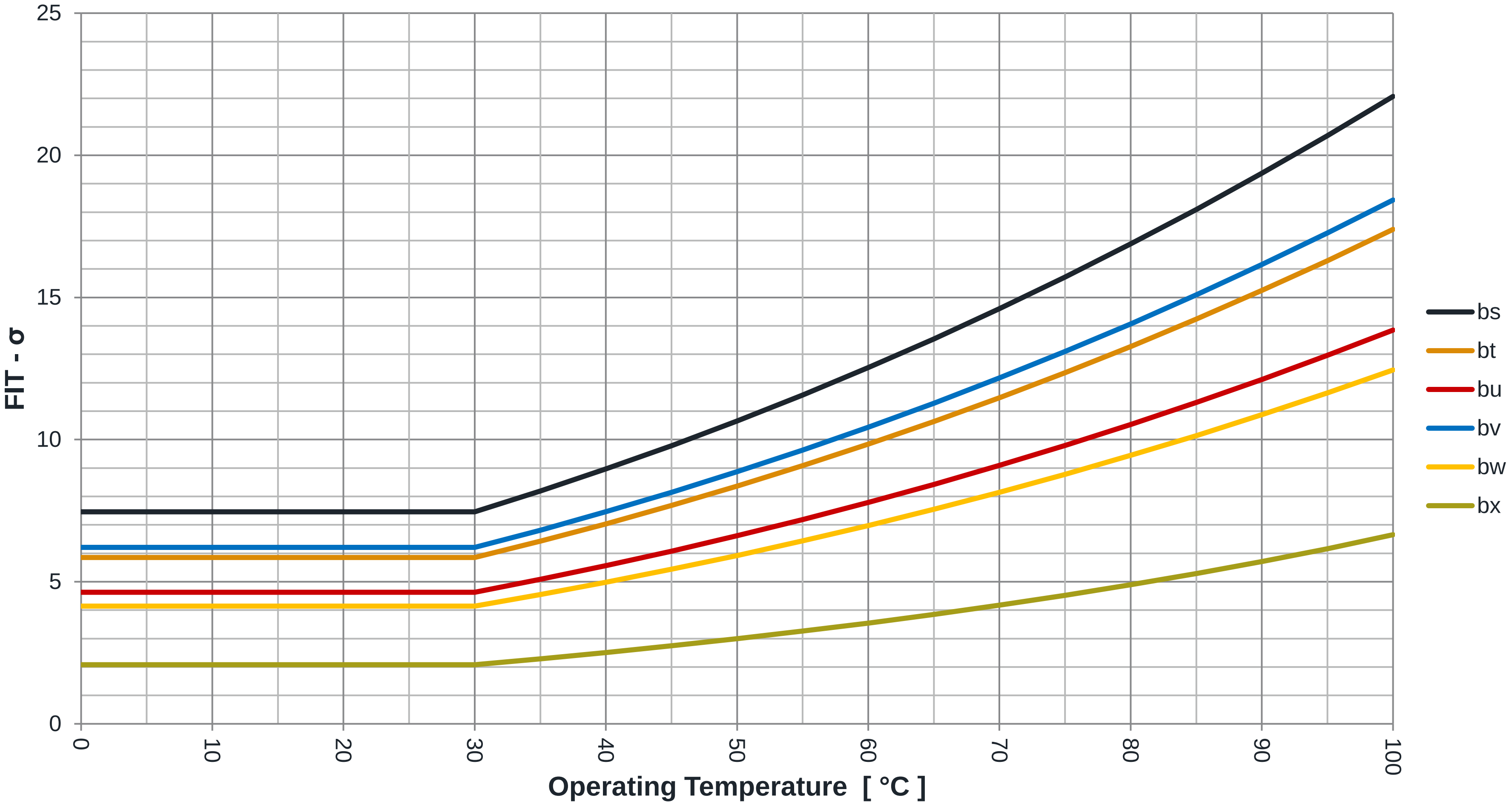
6.10 Graph σ-values



6.11 Graph σ-values

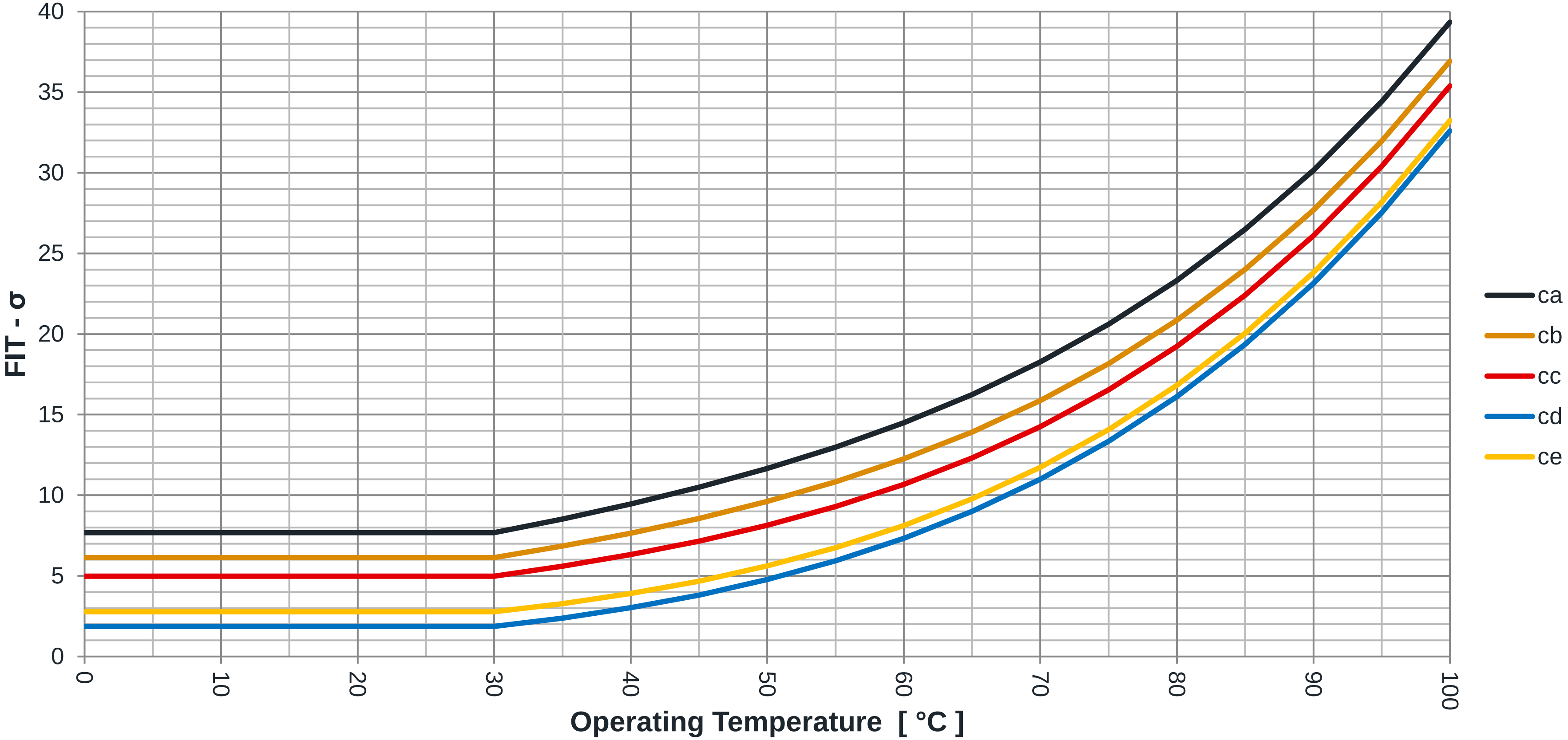


6.12 Graph σ-values



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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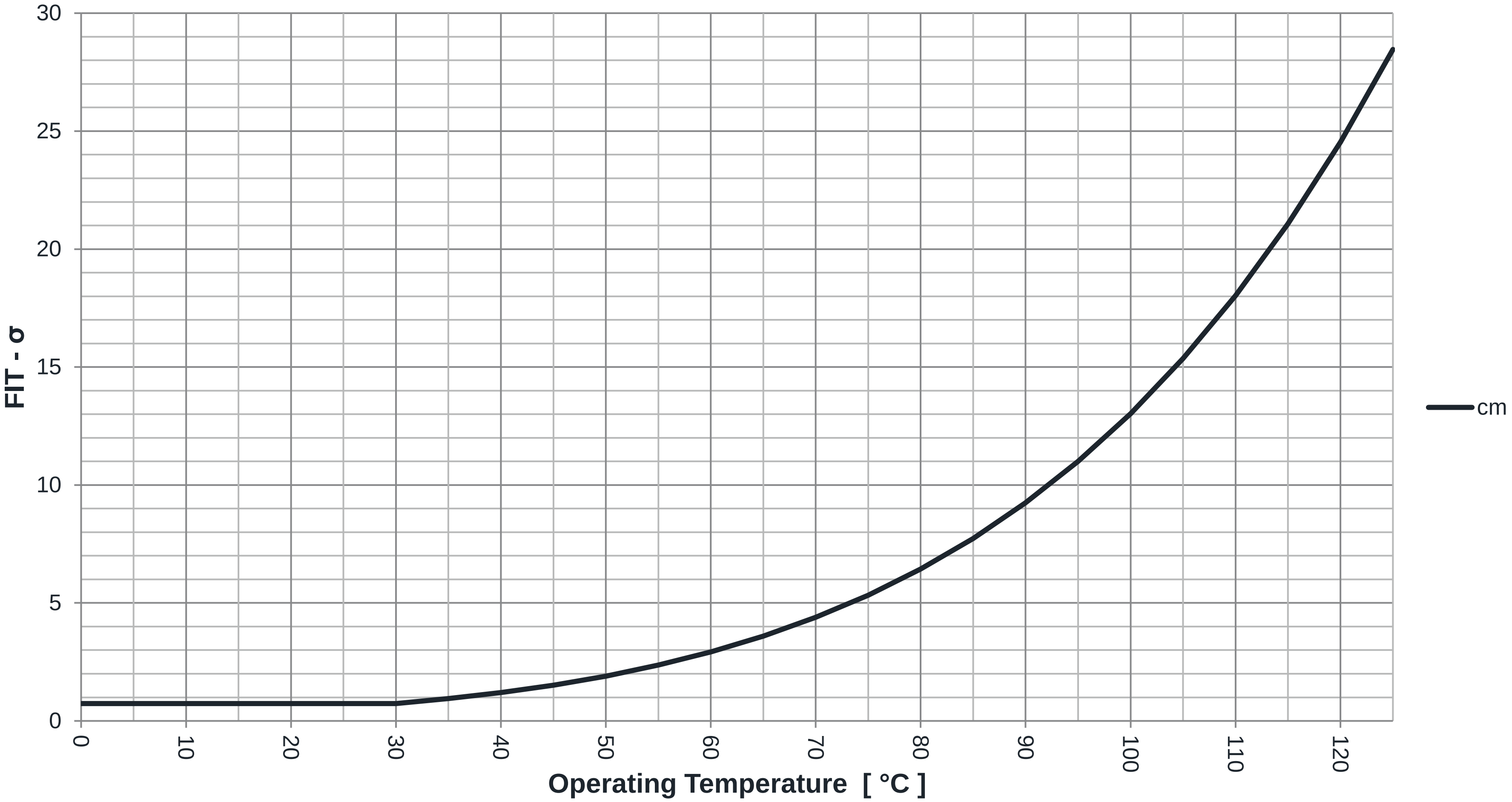
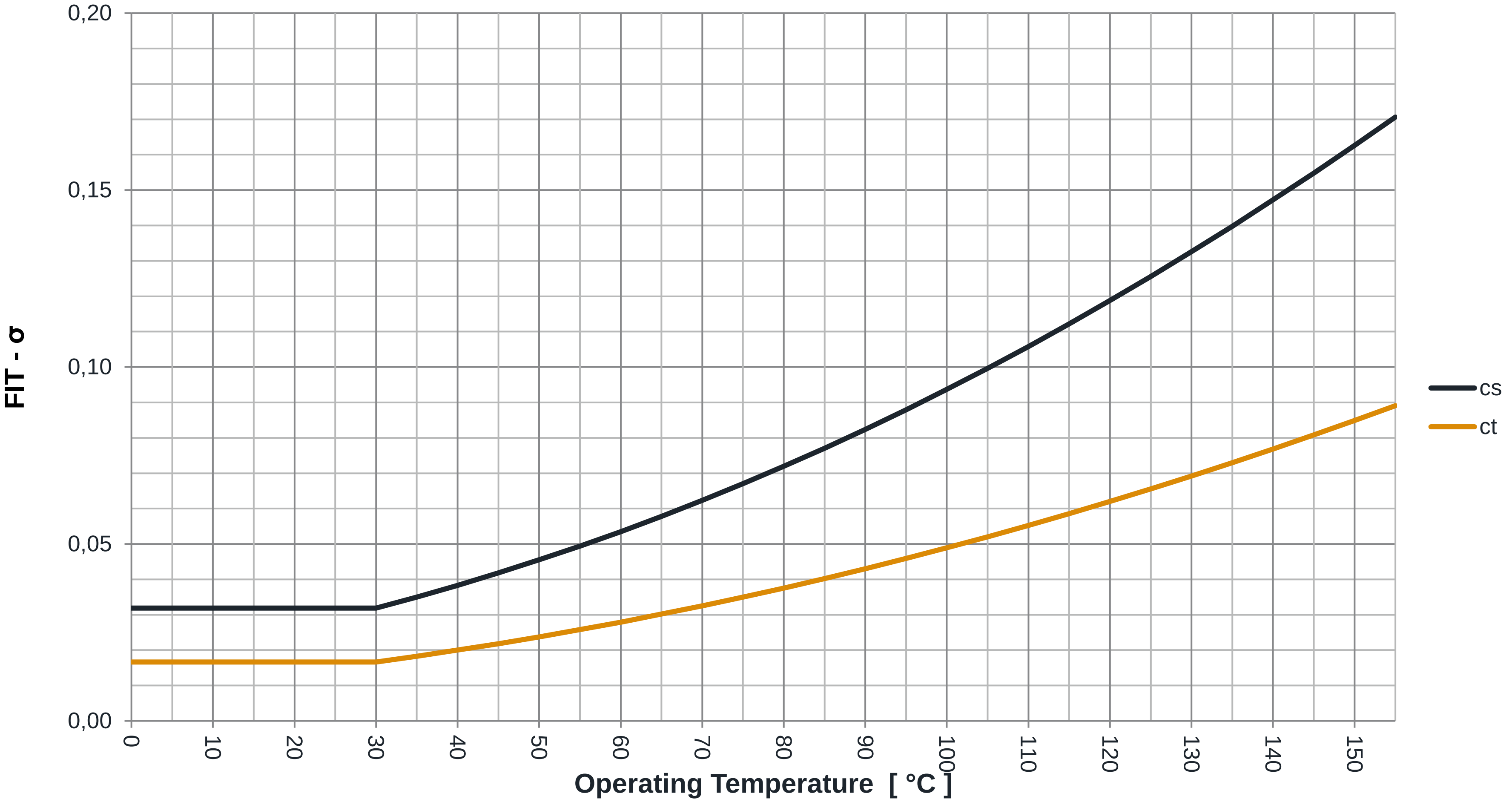
6.15 Graph σ-values



6.16 Graph σ-values



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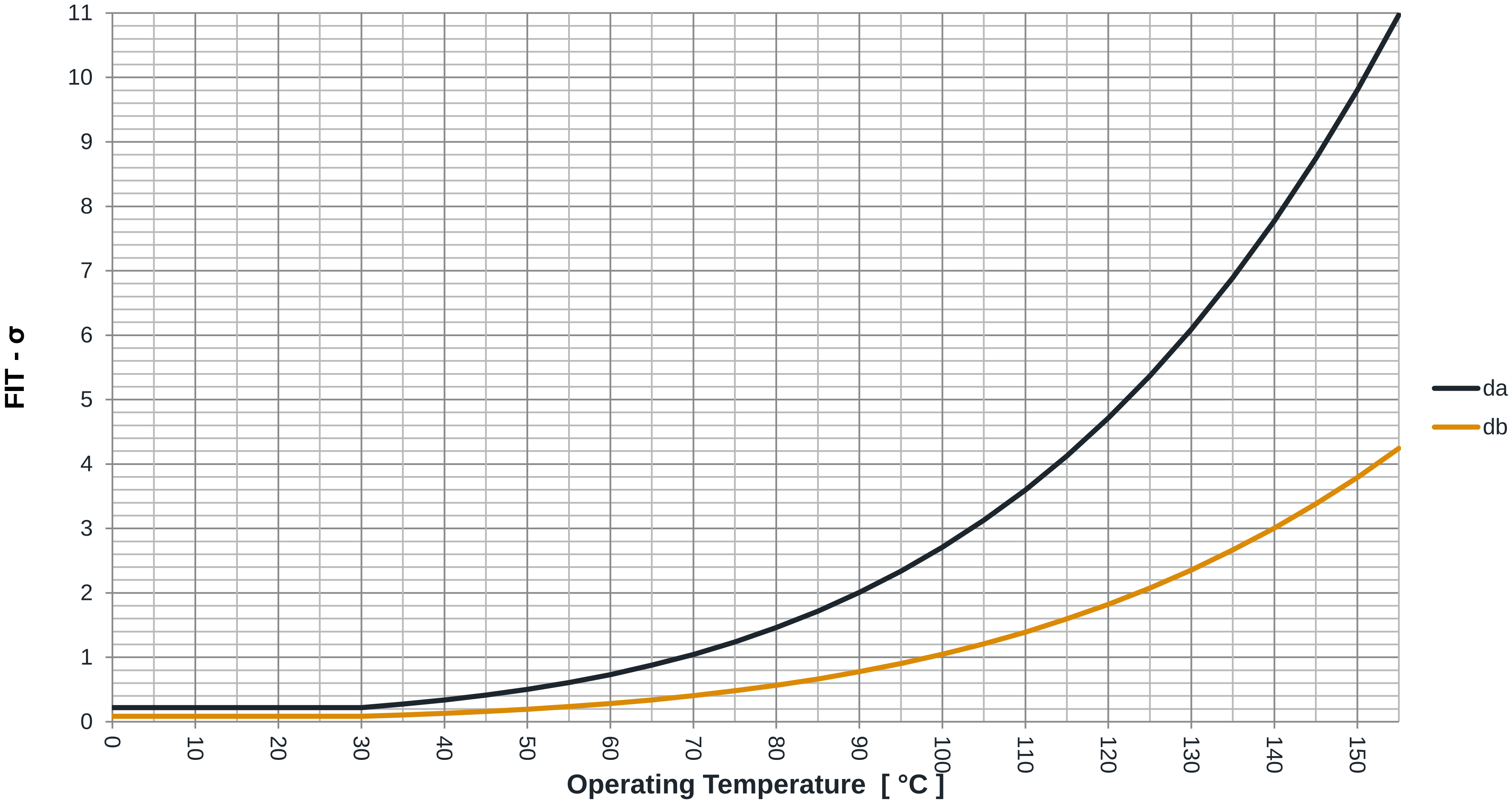
6.17 Graph σ-values



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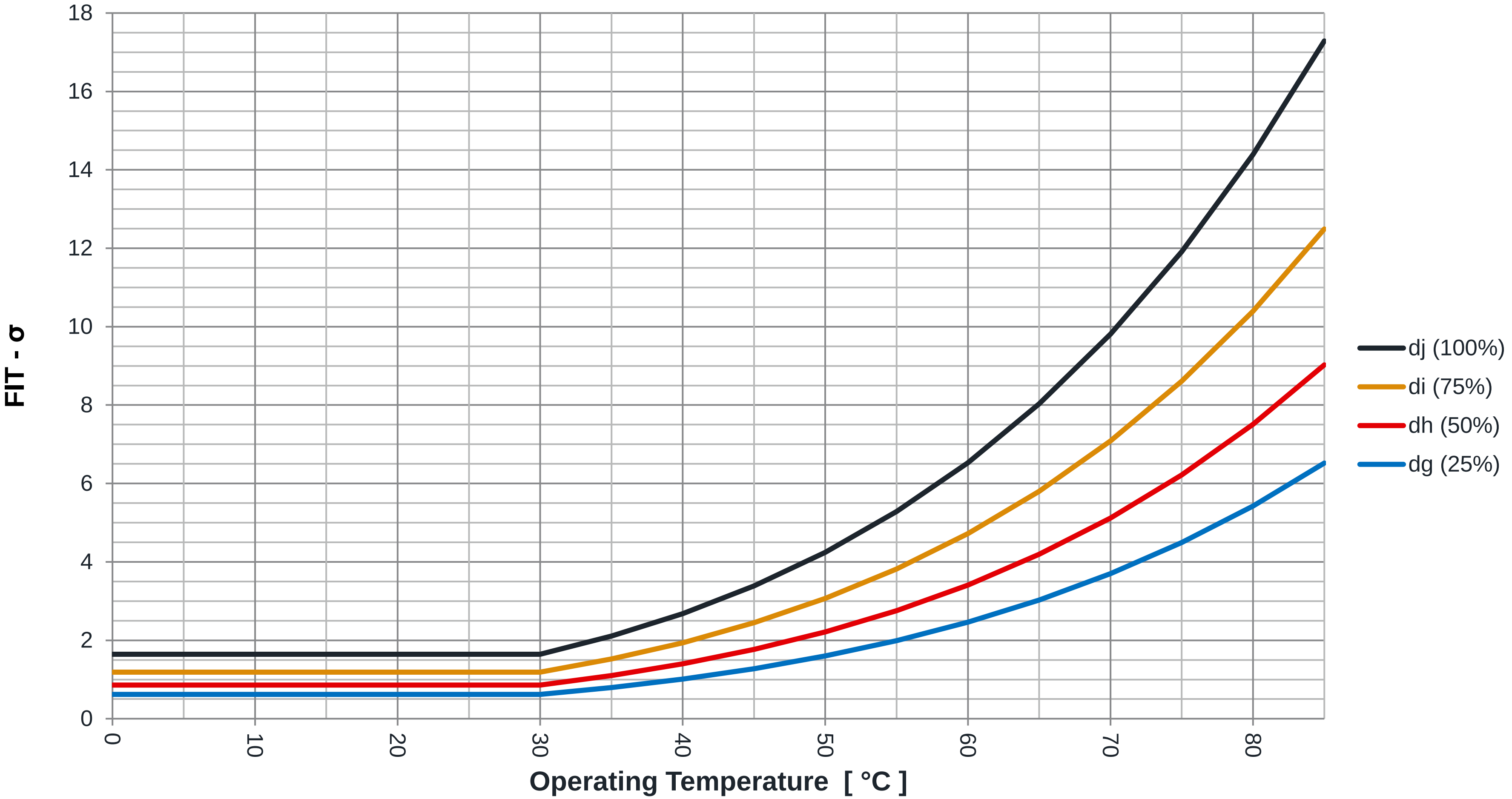
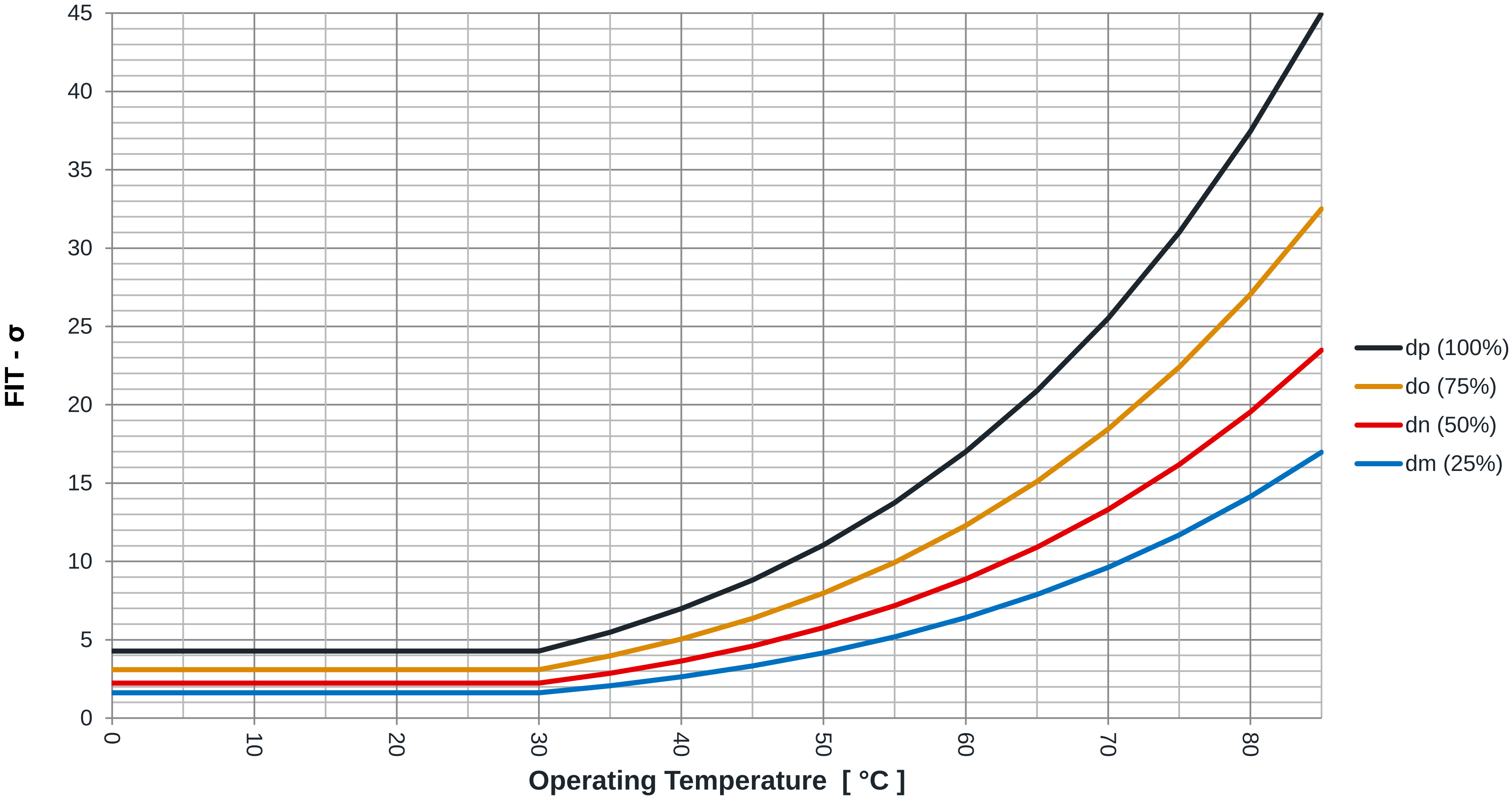
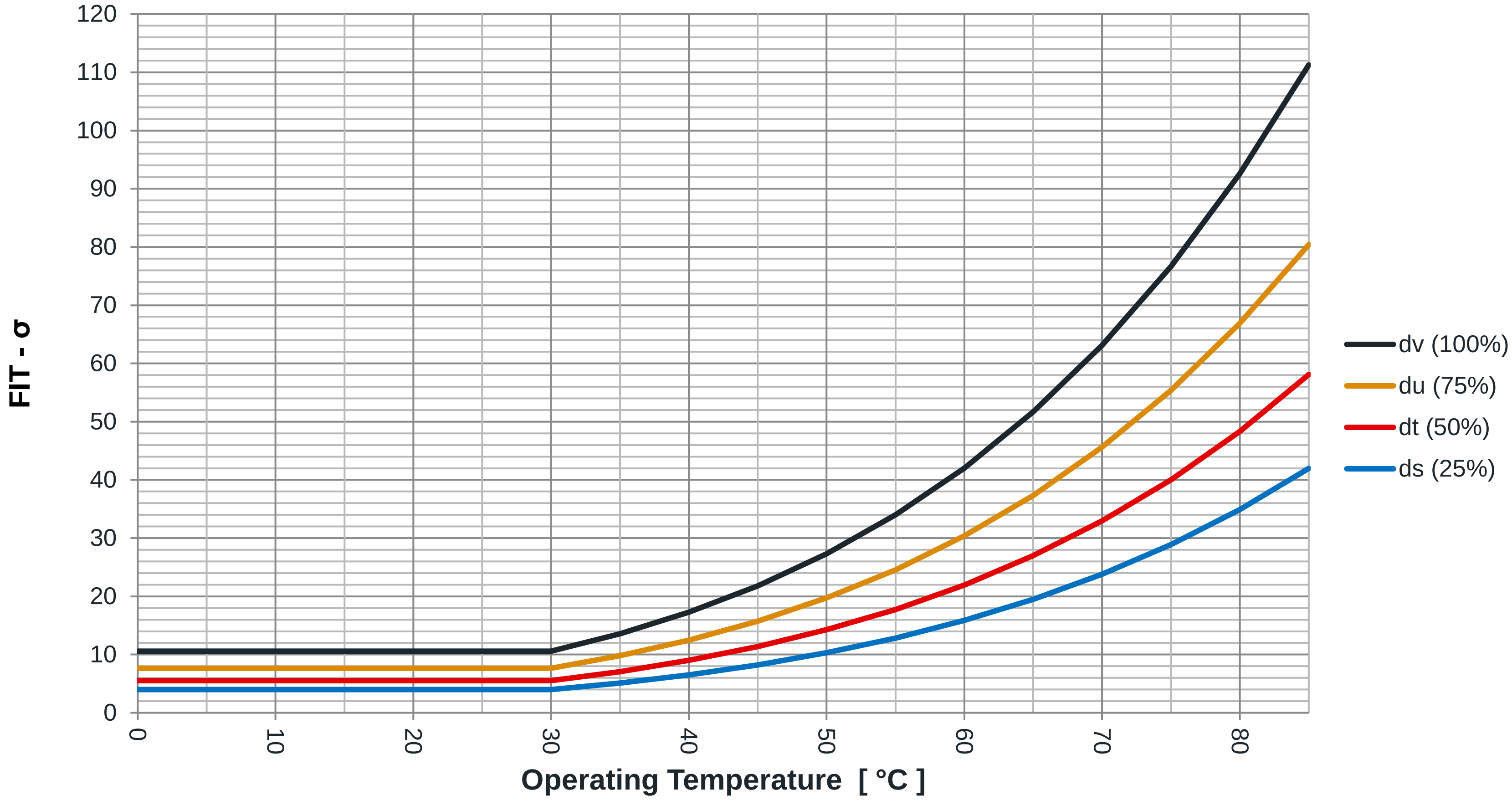
6.18 Graph σ-values



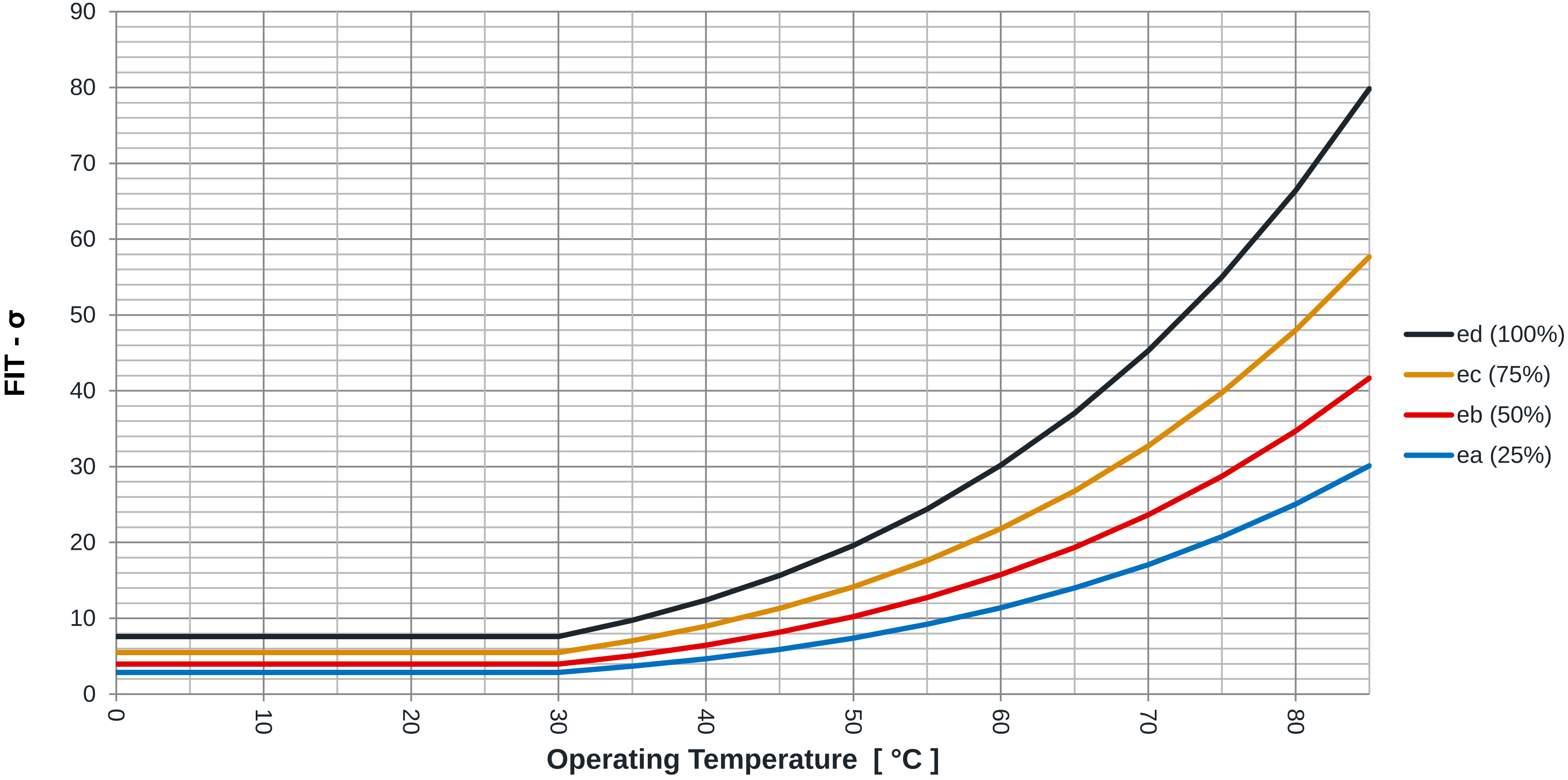
6.19 Graph σ-values



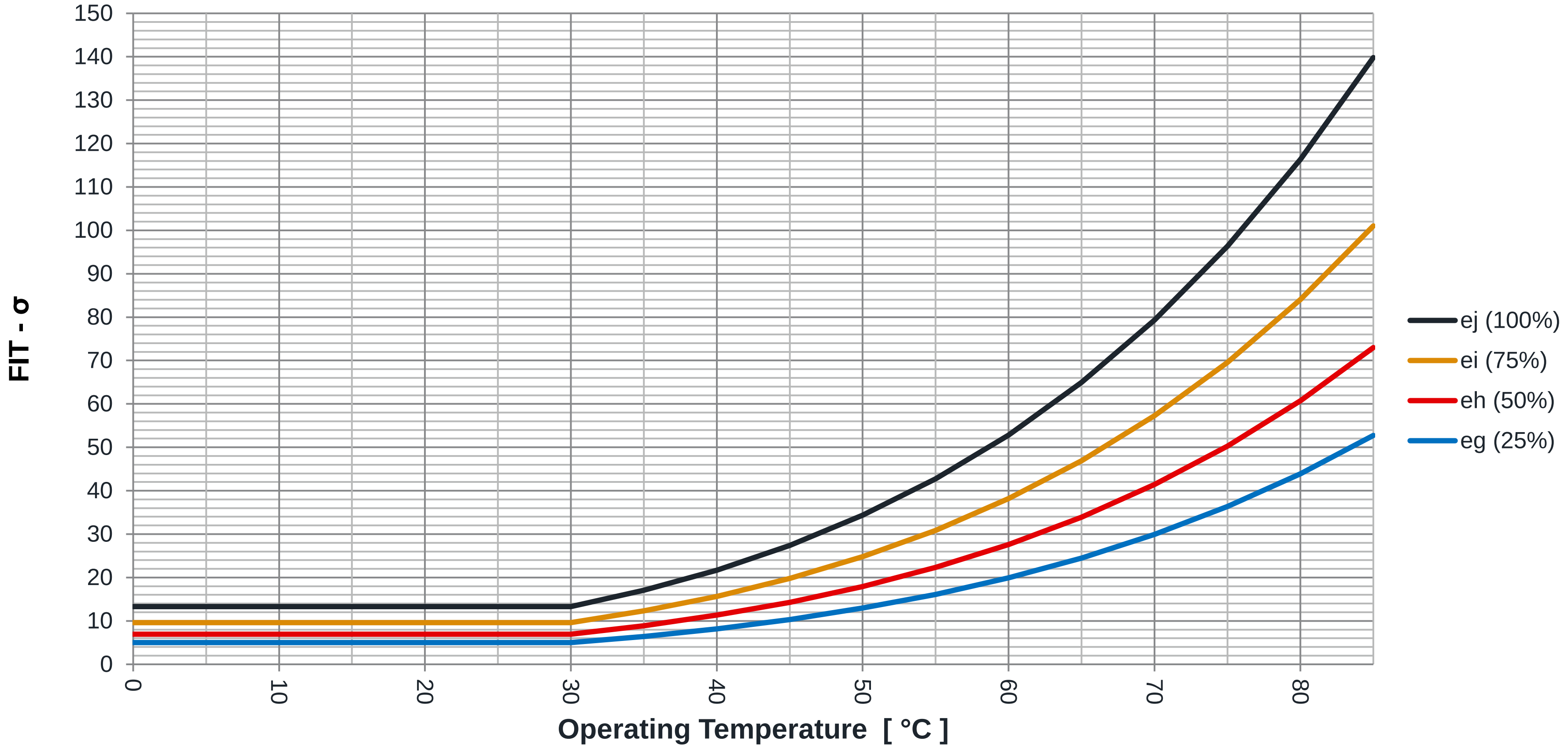
6.20 Graph σ-values



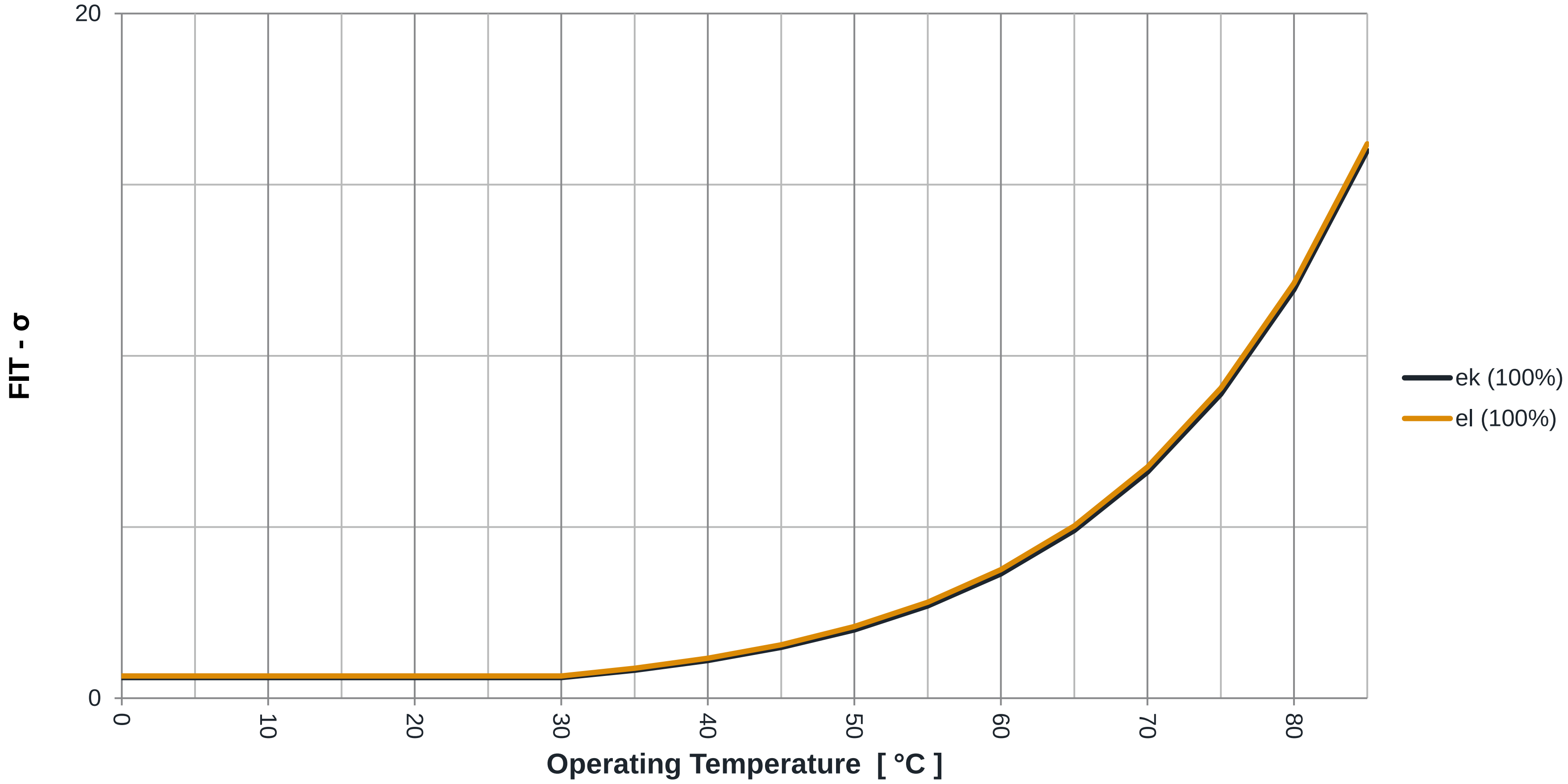
6.21 Graph σ-values



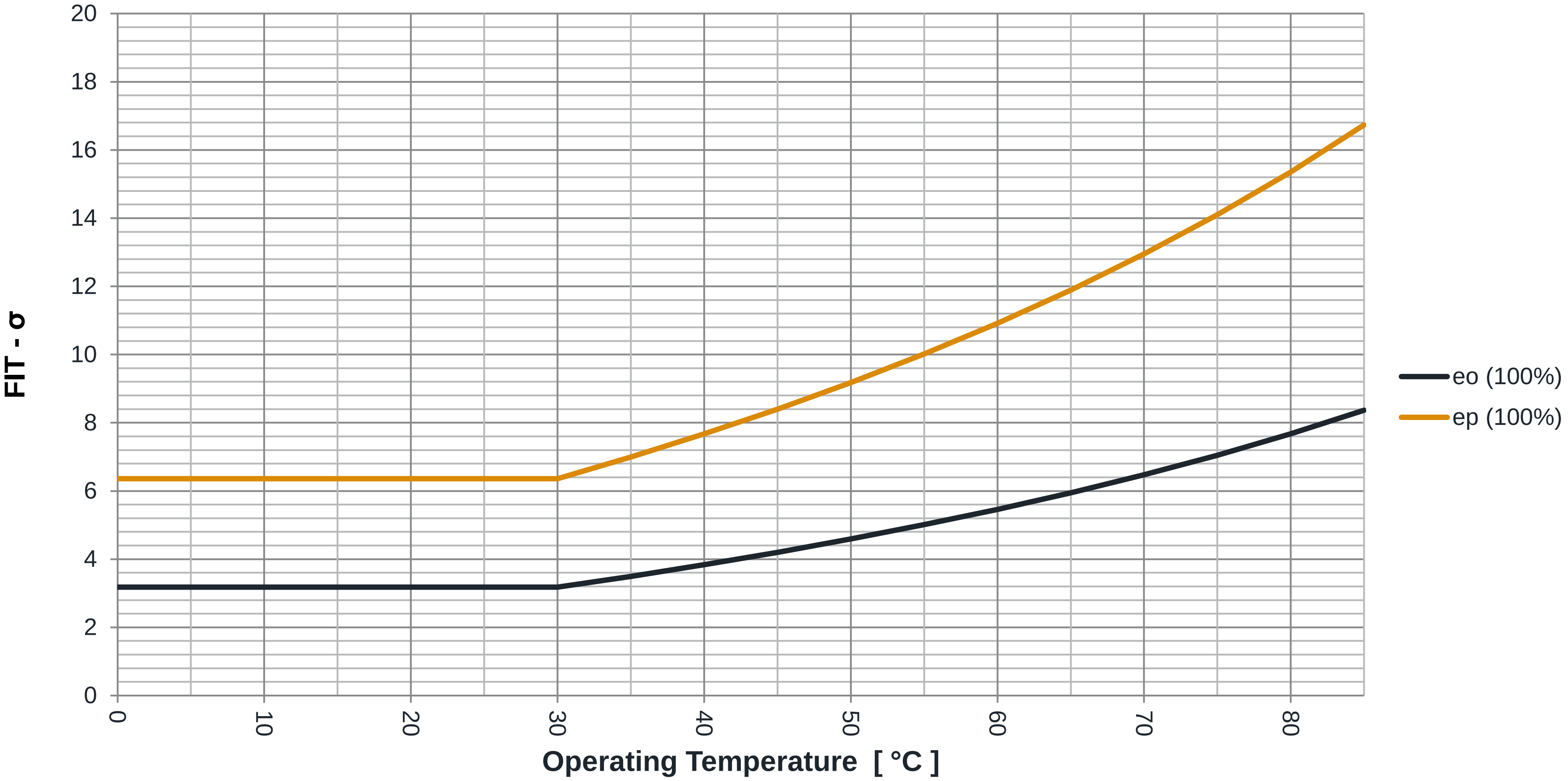
6.22 Graph σ-values



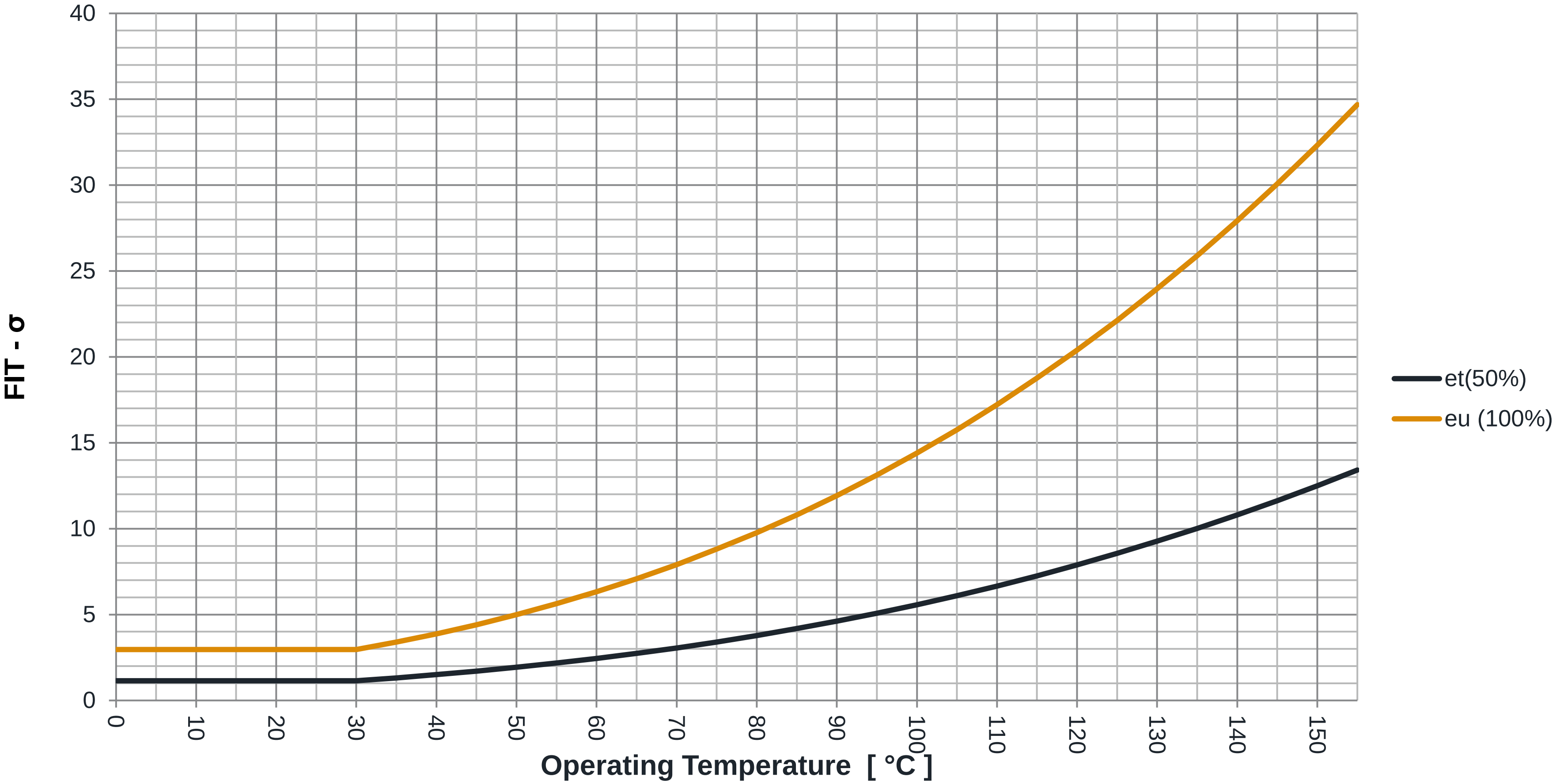
6.23 Graph σ-values



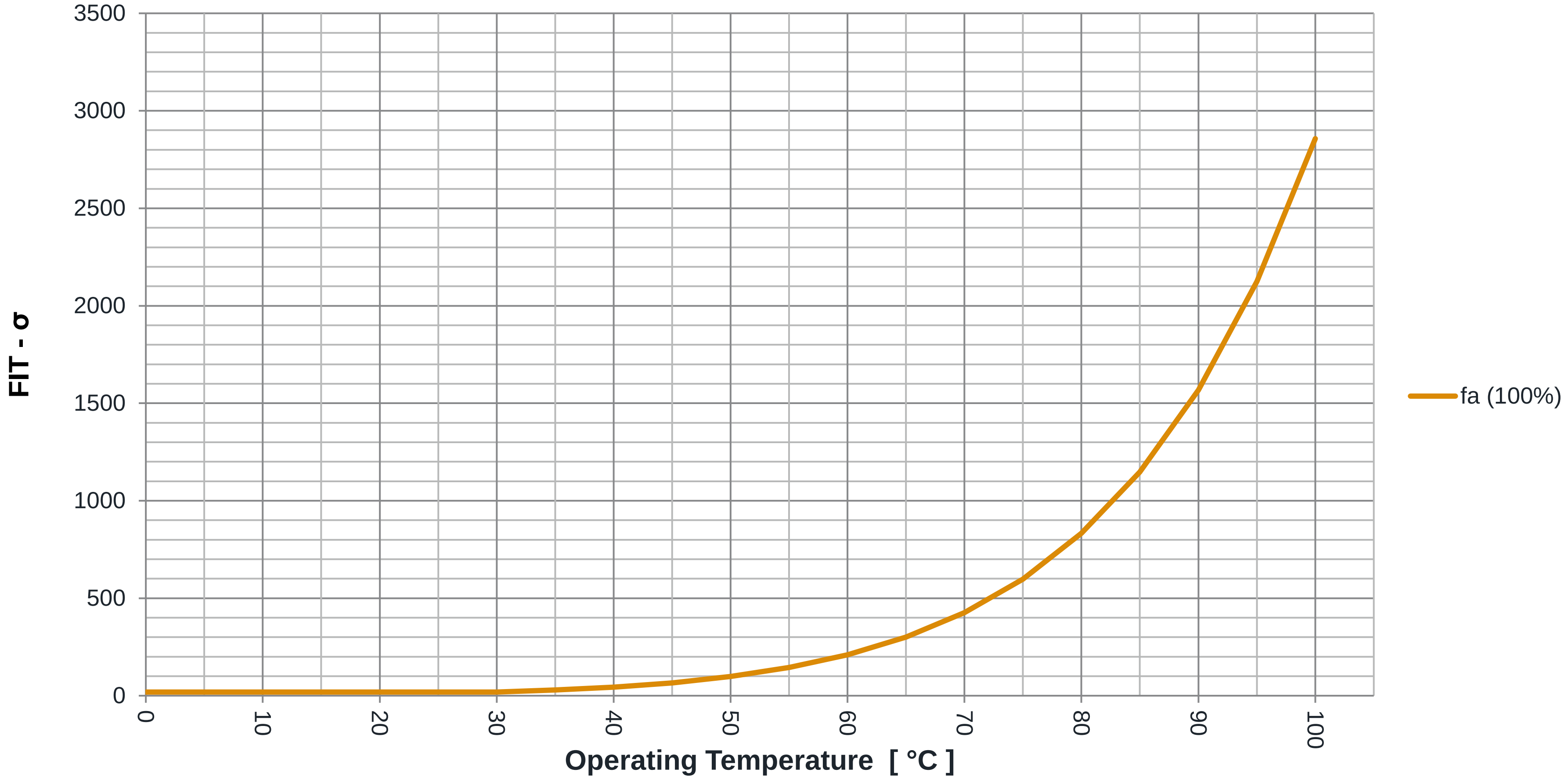
6.24 Graph σ-values



6.25 Graph σ-values



6.26 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 K and scale parameters θ as following:

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

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

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

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

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

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 Frequently Asked Questions (FAQs)

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 "**F**ailures **I**n **T**ime" and is a key figure for the reliability of a product.
λ gives the predicted failures per 10^9 hours (114k years) of operation <u>during the steady state region</u> of its expected lifetime. (See the figure in section 8.6)

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 **M**ean **T**ime **B**etween **F**ailures 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 FIT values to MTBF or the other way around?

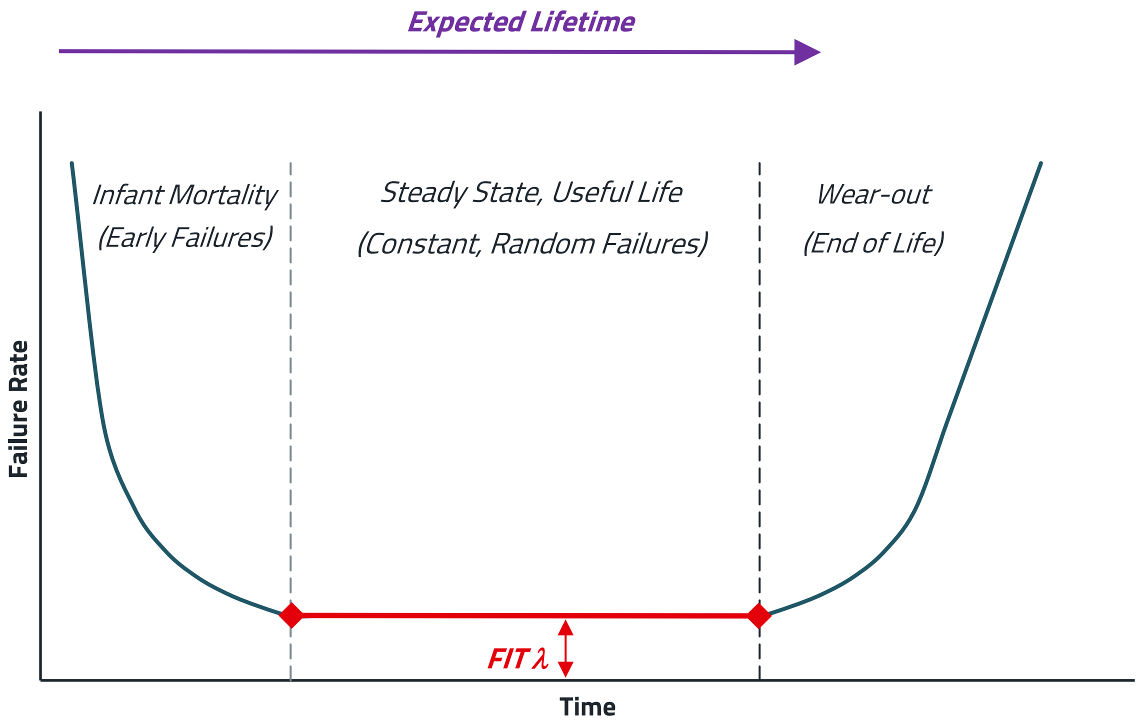
Since MTBF and FIT are just 2 different kinds to describe the failure rate, they can be converted by the formulas given below:

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

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 **M**ean **T**ime **B**etween **F**ailures 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.

For example, suppose there are 1 million phone chargers in operation for 6 hours a day. In 5 days, there are 12 random failures. This means that there are 12 failures per 30 million operating hours. Although there are different methods for calculating MTBF based on failures and operating hours, we can estimate an MTBF between 2 – 2.5 million hours for this example. Clearly, a phone charger is not expected to last 200+ years. Rather, MTBF or FIT is a measure of the random failures of products that are operating during the period of their useful life where we normally do not expect failures to occur.

8.8 How long is the Infant Mortality Period?

The infant mortality period (as shown in the figure in section 8.6) is assumed to be the first 10^4 hours, or a little more than one year.

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

Some components do not have a defined FIT rate. In these cases, the particular product type is not defined in the Telcordia SR-332 standard. 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. In other cases, a particular component type simply might not have enough significant field data to have a FIT determination 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.

8.11 What else should be considered when calculating system failure rates?

There are many methods, standards, and variables that are considered in the determination of FIT rates of components and systems. The standards consider some factors, such as temperature, electrical stress, and manufacturer quality controls. However, additional variables can influence failure rates, including board connections, board assembly processes, circuit layout and design, external forces or stresses, and other environmental factors.

Therefore, FIT rates are not measurements and cannot be guaranteed. Rather, they are prediction tools for comparing the reliability of different board designs, and indicating circuit failure behavior with a certain degree of confidence.

When calculating system failure rates, the purpose of the failure rate should be considered. Is the intent to estimate the service availability, or is the intent to estimate return rates of the product? System failure rates are often calculated by a summation of individual components, i.e. the "parts count" method. However, this method does not naturally account for whether components are critical to the system. For example, if an LED stops emitting light, the system might continue to function as normal. Also, some systems might have "fail-safes" or redundancies built in, in which case a failure of certain components does not cause a system failure. Acceptable performance levels must also be considered when calculating system FIT rates. The intent and usage of the system failure rate data should be carefully considered when including components in FIT rate calculations.

9 Referenced Documents

External Documents and Standards		
No. / Name	**Document title / Description:**	**Date:**
SR-332 v3	Reliability Prediction Procedure for Electronic Equipment, Issued by Telcordia	Feb-2011
MIL-HDBK-217F	Military Handbook: Reliability Prediction of Electronic Equipment, Issued by United States Dept of Defense	2-Dec-1991

Würth Elektronik Internal Documents		
No. / Name:	**Document title / Description:**	**Date:**
ANO006	Application Note: Lifetime of Optocouplers, Issued by Würth Elektronik	17-Feb-2021

Note: Würth Elektronik Internal Documents are available upon request. Please request from your direct contact.

10 Disclaimer

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