

# Product/Process Change Notification

N° 2020-121-A2

Dear customer,

please find attached our Infineon Technologies AG PCN:

## Introduction of an additional plating subcon affecting dedicated products

Important information for your attention:

- Please respond to this PCN by indicating your decision on the approval form, sign it and return to your sales partner before 2021-07-28.
- Infineon aligns with the widely-recognized JEDEC STANDARD “JESD46”, which stipulates: “Lack of acknowledgement of the PCN within 30 days constitutes acceptance of the change.” Notwithstanding the aforesaid individual agreements shall prevail.

Your prompt reply will help Infineon to assure a smooth and well-executed transition. If Infineon does not hear from your side by the due date, we will assume your full acceptance to this proposed change and its implementation.

Your attention and response to this matter is greatly appreciated.



On 16 April 2020, Infineon acquired Cypress.

We are now in the process of merging and consolidating our tools and processes for PCN, Information Notes, Errata and Product Discontinuance. We ask for your patience in the meantime. For further details, please visit our website:

<https://www.infineon.com/cms/en/about-infineon/company/cypress-acquisition/>

Infineon Technologies AG

Postal Address Headquarters: Am Campeon 1-15, D-85579 Neubiberg, Phone +49 (0)89 234-0

Chairman of the Supervisory Board: Dr. Wolfgang Eder

Management Board: Dr. Reinhard Ploss (CEO), Dr. Helmut Gassel, Jochen Hanebeck, Constanze Hufenbecher, Dr. Sven Schneider

Registered Office: Neubiberg

Commercial Register: München HRB 126492

# Product/Process Change Notification

N° 2020-121-A2

## Products affected

Please refer to attached affected product list 1\_cip20121\_A2

## Detailed change information

### Subject:

Introduction of an additional plating subcon affecting dedicated products

### Reason/Motivation:

To ensure secure supply

Description	Old	New
<b>PROCESS - ASSEMBLY: Move all or parts of production to a different assembly site.</b>	Plating subcon: Ishizaki (SII) Sdn. Bhd, Malaysia	Plating subcon: Ishizaki (SII) Sdn. Bhd, Malaysia or Syntronix Asia (SA) Sdn. Bhd, Malaysia

## Product identification

Traceability is assured via internal lot number.

## Anticipated impact of change

based on the qualification performed, infineon does not expect any negative impact on quality and reliability.

No impact on fit, form and function

DeQuMa-ID(s): SEM-PA-18

## Attachments

1_cip20121_A2	affected product list
2_cip20121_A2	qualification report
3_cip20121_A2	customer information package

## Time schedule

Final qualification report	available
First samples available	on request
Intended start of delivery [1]	2021-07-31
Last order date (LOD) [2]	2022-01-31
Last delivery date (LDD) [3]	2022-07-31

[1] provided date or earlier after customer approval

[2] Last time buy volume to be placed latest until LOD

[3] Delivery of new product can be earlier (see Intended start of delivery) and depends on approval

## Product/Process Change Notification

N° 2020-121-A2

If you have any questions, please do not hesitate to contact your local sales office.

# Introduction of an additional plating subcon affecting dedicated products

Customer Information Package  
PCN 2020-121-A2



restricted

## Agenda

---

1	Motivation of the change	3
2	Change overview	5
3	5M+1E Evaluation and comparison	8
4	Environment comparison (environment)	11
5	Operator training (man)	14
6	Equipment comparison (machine)	16
7	Structure comparison table & materials (material)	18
8	Process flow comparison (method)	20

## Agenda

---

1	Motivation of the change	3
2	Change overview	5
3	5M+1E Evaluation and comparison	8
4	Environment comparison (environment)	11
5	Operator training (man)	14
6	Equipment comparison (machine)	16
7	Structure comparison table & materials (material)	18
8	Process flow comparison (method)	20

## Motivation of the change

---

- › To maintain secure supply of Infineon products to our customers, Infineon decided to add plating subcontractor Syntronixs Asia Sdn Bhd (SA), an ISO 9001 certified company, located in Malacca, Malaysia close to the Infineon Technology manufacturing plant for additional products.
- › For more than 10 years Infineon has a relationship with SA as plating subcontractor for different packages
- › SA will perform deflashing and plating processes for Infineon products. There are no significant differences in terms of equipment, process and material used compared to existing plating subcons. Qualification on reference products will ensure that Infineon's stringent quality targets are met and first positive readout results are available already.

## Agenda

---

1	Motivation of the change	3
2	<b>Change overview</b>	<b>5</b>
3	5M+1E Evaluation and comparison	8
4	Environment comparison (environment)	11
5	Operator training (man)	14
6	Equipment comparison (machine)	16
7	Structure comparison table & materials (material)	18
8	Process flow comparison (method)	20



## Change overview

---

Description	Old	New
Plating subcon	Ishizaki (SII) Sdn. Bhd, Malaysia	Ishizaki (SII) Sdn. Bhd, Malaysia or Syntronixs Asia (SA) Sdn. Bhd, Malaysia

## Syntronixs Asia (SA) : introduction

- › Started in mid 2007 & mass production commenced in Jan 2009, high volume production since 5 years for similar packages (e.g. DSO-8, DSO-14, SSOP24, LQFP)
- › Strategically located in Batu Berendam Free Industrial Zone, Melaka, close to our fab
- › Specialize in Tin (Sn) and Copper (Cu) plating, capable depending on customer requirements
- › Utilizing Mecco plating equipment – 17 plating lines in operation
- › Consist of experience crew (process and equipment) to ensure production stability and speed in NPI (new product introduction)
- › Available space options for future expansion possibilities to support customers' volume expansion



## Agenda

1	Motivation of the change	3
2	Change overview	5
3	<b>5M+1E Evaluation and comparison</b>	<b>8</b>
4	Environment comparison (environment)	11
5	Operator training (man)	14
6	Equipment comparison (machine)	16
7	Structure comparison table & materials (material)	18
8	Process flow comparison (method)	20

## 5M+1E Evaluation method

---

- › The 5M+1E is a method used to analyze causes and consequences.
- › The method is used to identify and prevent potential factors causing problems in production processes and having an overall effect.
- › Causes are grouped into 6 major categories to identify and classify these sources of variation
  - 5M:
    - Man, Machine, Material, Method, Measurement
  - 1E:
    - Environment

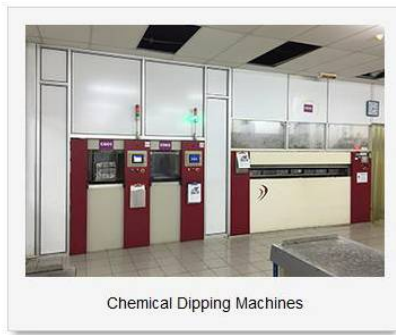
## 5M+1E Evaluation and comparison

No	Items	Comparison		Concerning point	Check Items	Check result	Evidence
		Existing	After PCN				
1	Environment	Ishizaki (SII), Melaka	Syntronixs Asia (SA), Melaka	Reduced solderability and increased delamination due to environment differences	Process comparison and qualification	Process parameter and qualification results are comparable	N/A
2	Man	Ishizaki (SII), Melaka	Syntronixs Asia (SA), Melaka	Different operation due to lack of operator training	Operator training	Similar level of training is implemented in both locations	Certification
3	Machine	Chemical DIP High Pressure Water Jet Sn Plating	Chemical DIP High Pressure Water Jet Sn Plating	Product performance and reliability risk	Process comparison and qualification	Process parameter and qualification results are comparable	1. Process comparison 2. Qualification results 3. Machine comparison table
4	Material	Plating chemistry	Plating chemistry	Reduced solderability and increased delamination due to material differences	Process comparison and qualification	Process parameter and qualification results are comparable	1. Process comparison 2. Qualification results 3. Material comparison table
5	Method	Chemical DIP Sn Plating	Chemical DIP Sn Plating	Reduced solderability and increased delamination due to process differences	Process comparison and qualification	Process parameter and qualification results are comparable	1. Process comparison 2. Qualification results
6	Measurement	N/A	N/A	N/A	N/A	N/A	N/A

## Agenda

1	Motivation of the change	3
2	Change overview	5
3	5M+1E Evaluation and comparison	8
4	<b>Environment comparison (environment)</b>	<b>11</b>
5	Operator training (man)	14
6	Equipment comparison (machine)	16
7	Structure comparison table & materials (material)	18
8	Process flow comparison (method)	20

# Syntronixs Asia Sdn. Bhd Plating and Annealing Equipment





Fully Automated Solderability Tester



Baking Oven



X-ray



## Agenda

---

1	Motivation of the change	3
2	Change overview	5
3	5M+1E Evaluation and comparison	8
4	Environment comparison (environment)	11
5	<b>Operator training (man)</b>	<b>14</b>
6	Equipment comparison (machine)	16
7	Structure comparison table & materials (material)	18
8	Process flow comparison (method)	20

# Man: Operator training



## Agenda

---

1	Motivation of the change	3
2	Change overview	5
3	5M+1E Evaluation and comparison	8
4	Environment comparison (environment)	11
5	Operator training (man)	14
6	<b>Equipment comparison (machine)</b>	<b>16</b>
7	Structure comparison table & materials (material)	18
8	Process flow comparison (method)	20

## Machine: Equipment comparison for plating



No	Breakdown of Tool Delta	Ishizaki (SII)	Syntronixs Asia (SA)	Assessment
1	Chemical dip	Custom Made Semi-Auto CD	Steda 1500	Comparable Process Performance
2	Water jet	MECO in-line with Sn plating	Steda & MECO	Comparable Process Performance
3	Sn plating	MECO	MECO	Comparable Process Performance
4	Annealing	Espec	Blue M / Enviro / Espec	Comparable Process Performance

- > Comparable Process Performance for all different equipment

## Agenda

---

1	Motivation of the change	3
2	Change overview	5
3	5M+1E Evaluation and comparison	8
4	Environment comparison (environment)	11
5	Operator training (man)	14
6	Equipment comparison (machine)	16
7	<b>Structure comparison table &amp; materials (material)</b>	<b>18</b>
8	Process flow comparison (method)	20

## Materials comparison table plating

- › Materials and suppliers used at Ishizaki (SII) and Syntronixs Asia (SA) are comparable

Items	Ishizaki (SII)	Syntronixs Asia (SA)
Chemical dip chemistry	Supplier A Material: A1	Supplier B Material: A2
Plating bath	Supplier C Material: C1	Supplier C Material: C2
Electro-degrease chemistry	Supplier D Material: D1	Supplier D Material: D2
Cu descaler chemistry	Supplier E Material: E1	Supplier F Material: E1
Pre dip chemistry	Supplier G Material: G1	Supplier H Material: G1
Sn plating chemistry	Supplier I Material: I1*	Supplier I Material: I2*

\* material used for the plating process has a slight difference but leading to same pure Sn plating

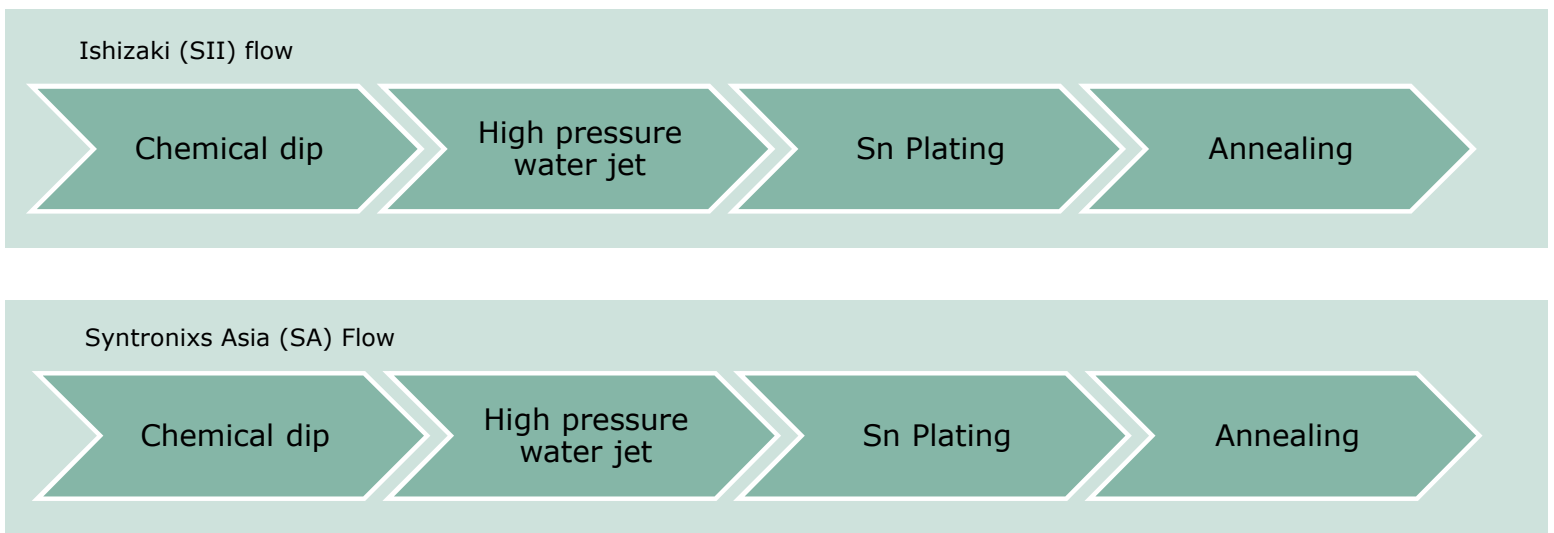
## Agenda

---

1	Motivation of the change	3
2	Change overview	5
3	5M+1E Evaluation and comparison	8
4	Environment comparison (environment)	11
5	Operator training (man)	14
6	Equipment comparison (machine)	16
7	Structure comparison table & materials (material)	18
8	Process flow comparison (method)	20

## Process flow comparison

- › Process flow used at Ishizaki (SII) and Syntronixs Asia (SA) are comparable







Part of your life. Part of tomorrow.

<b>Infineon Technologies AG</b>	<b>Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev. H</b>	<b>ATV QM</b>
---------------------------------	--	---------------

Project	TDSO Subcon Plating at Syntronixs Asia (SA)	Date: 2021-06-15
Part for family qualification	TLE5014C16D, TLE4998C8D, TLE5309D E1211, TLE4999C8	Department: IFAG ATV QM SC MSS
Chips for family qualification	M5014A, M4998L, M5009A (top) / M5109A (bottom), M4991A	Provided by: L. Langkopf, S. Vasquez-Borucki, M. Schindler, F. Durrani
Device family	Linear Hall and Angle Sensor product families	Reviewed by: J. Specht, F. Schröppel
Qualification no.	Q20ETS05	

Part Operating Temperature Grade 1: -40°C to 125°C ambient Operating Temperature Range

	Part	Chip	Chip size [ mm² ]	Wafer diameter [mm]	Wafer fab	Wafer technology	Package	Assembly line
Part to be Qualified	TLE5014C16D	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Qualified	TLE4998C8D	M4998L	2.90 x 1.90	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia
Part to be Qualified	TLE5309D E1211	M5009A (top) M5109A (bottom)	1.40 x 1.40 1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR C9FLRN_AMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Qualified	TLE4999C8	M4991A	1.46 x 1.61	200	Infineon Technologies Dresden, Germany	SPT9_S8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5014S16D	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5014P16D	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5014C16D E0015	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5014SP16D E0002	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5014C16	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia

Infineon Technologies AG							Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev. H		ATV QM
Part to be Released	TLE5014S16	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5014P16	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5014SP16 E0001	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5014SP16 E0002	M5014A	1.90 x 1.60	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	SPT9_xMR8	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4997A8D	M4997K	2.95 x 2.20	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4997A8D	M4997M	2.95 x 2.20	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4997A8D E0300	M4997K	2.95 x 2.20	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4997A8D E0300	M4997M	2.95 x 2.20	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4997A8	M4997K	2.95 x 2.20	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4997A8	M4997M	2.95 x 2.20	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998C8D	M4998B	2.90 x 1.90	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998P8D	M4998K	2.90 x 1.90	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998P8D	M4998A	2.90 x 1.90	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998S8D	M4998L	2.90 x 1.90	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998S8D	M4998B	2.90 x 1.90	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-2	Infineon Technologies Melaka, Malaysia	

Infineon Technologies AG							Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev. H		ATV QM
Part to be Released	TLE4998C8	M4998L	2.90 x 1.90	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998C8	M4998B	2.90 x 1.90	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998P8	M4998K	2.90 x 1.90	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998P8	M4998A	2.90 x 1.90	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998S8	M4998L	2.90 x 1.90	200	Infineon Technologies Kulim Sdn Bhd	B6CAS_8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE4998S8	M4998B	2.90 x 1.90	200	Infineon Technologies Regensburg, Germany	B6CAS_8	PG-TDSO-8-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5009A16D E1200	M5009A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5009A16D E1210	M5009A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5009A16D E2200	M5009A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5009A16D E2210	M5009A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5009A16 E1200	M5009A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5009A16 E2200	M5009A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5009A16 E2210	M5009A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5012BD E1200	M5012B	2.00 x 2.00	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia	
Part to be Released	TLE5012BD E9200	M5012B	2.00 x 2.00	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia	

<b>Infineon Technologies AG</b>	<b>Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev. H</b>	<b>ATV QM</b>
---------------------------------	--	---------------

Part to be Released	TLE5309D E2211	M5009A (top) M5109A (bottom)	1.40 x 1.40 1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR C9FLRN_AMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5309D E5201	M5009A (top) M5109A (bottom)	1.40 x 1.40 1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_GMR C9FLRN_AMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5109A16D E1210	M5109A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_AMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5109A16D E2210	M5109A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_AMR	PG-TDSO-16-2	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5109A16 E1210	M5109A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_AMR	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia
Part to be Released	TLE5109A16 E2210	M5109A	1.40 x 1.40	200	Infineon Technologies Dresden, Germany & Infineon Technologies Regensburg, Germany	C9FLRN_AMR	PG-TDSO-16-1	Infineon Technologies Melaka, Malaysia

**Result:**                      **Qualification passed**

Infineon Technologies AG		Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev. H										ATV QM		
Project		TDSO Subcon Plating at Syntronixs Asia (SA)										Date:	2021-06-15	
Device no. for family qualification		TLE5014C16D, TLE4998C8D, TLE5309D E1211, TLE4999C8										Department:	IFAG ATV QM SC MSS	
Chip no. for family qualification		M5014A, M4998L, M5009A (top) / M5109A (bottom), M4991A										Provided by:	L. Langkopf, S. Vasquez-Borucki, M. Schindler, F. Durrani	
Device family		Linear Hall and Angle Sensor product families										Reviewed by:	J. Specht, F. Schröppel	
Qualification no.		Q20ETS05												
TEST#	STRESS TEST according AEC Q100 Rev.H	Test conditions	# LOTS	Sample Size	Duration	Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Remarks
						TLE5014C16D M5014A		TLE4998C8D M4998L		TLE5309D E1211 M5009A (top) M5109A (bottom)		TLE4999C8 M4991A		
						Fail	Devices	Fail	Devices	Fail	Devices	Fail	Devices	
A1	Solder Preconditioning; MSL3/ 260°C J-STD-020; JESD22-A113	moisture soak 192h 30°C/60%r.h.	3 1	231 77	-	0	231	0	231	0	231	0	77	Preconditioning before tests # A2, A3, A4
A2	Temperature Humidity Bias	85°C/85%r.h. Vs= 3.3V	3	77	500h 1000h	0 77	77	0 77	77	0 77	77	-	-	Acc. to Table 2A, AEC Q100 Rev.H WBP of 3 lots PASSED
A3	Unbiased HAST	110°C / 85% r.h.	4	77	264h	0	77	0	77	0	77	0	77	Acc. to Table 2A, AEC Q100 Rev.H
A4	Temperature Cycling	-55°C / +150°C	3	77	500c 1000c	0 77	77	0 77	77	0 77	77	-	-	Acc. to Table 2A, AEC Q100 Rev.H
A5	Power Temperature Cycling		-	-	-	-	-	-	-	-	-	-	-	Not applicable: Device is rated < 1W and ΔT <sub>j</sub> < 40°C
A6	High Temperature Storage Life	Ta = +150°C	4	77	500h 1000h	0 77	77	0 77	77	0 77	77	0 77	77	
B1	High Temperature Operating Life		-	-	-	-	-	-	-	-	-	-	-	Not applicable: HTOL is not requested according to AEC Q100
B2	Early Life Failure Rate		-	-	-	-	-	-	-	-	-	-	-	Not applicable: New plating supplier is not expected to affect the ELFR of SC products in TDSO package.
B3	NVM Endurance, Data Retention		-	-	-	-	-	-	-	-	-	-	-	Not applicable: NVM Endurance test not related to plating process change.

**Infineon Technologies AG** **ATV QM**  
**Component Qualification Test Plan for Packaged Integrated Circuits**  
**according to AEC Q100 Rev. H**

Project	TDSO Subcon Plating at Syntronixs Asia (SA)	Date:	2021-06-15
Device no. for family qualification	TLE5014C16D, TLE4998C8D, TLE5309D E1211, TLE4999C8	Department:	IFAG ATV QM SC MSS
Chip no. for family qualification	M5014A, M4998L, M5009A (top) / M5109A (bottom), M4991A	Provided by:	L. Langkopf, S. Vasquez-Borucki, M. Schindler, F. Durrani
Device family	Linear Hall and Angle Sensor product families	Reviewed by:	J. Specht, F. Schröppel
Qualification no.	Q20ETS05		

TEST#	STRESS TEST according AEC Q100 Rev.H	Test conditions	# LOTS	Sample Size	Duration	Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Remarks
						Fail	Devices	Fail	Devices	Fail	Devices	Fail	Devices	
						TLE5014C16D M5014A		TLE4998C8D M4998L		TLE5309D E1211 M5009A (top) M5109A (bottom)		TLE4999C8 M4991A		
						Fail	Devices	Fail	Devices	Fail	Devices	Fail	Devices	
C1	Wire Bond Shear		3	10 / 30 bonds	-	0	30	0	30	0	30	-	-	AEC Q100-001, AEC Q003
C2	Wire Bond Pull		3	10 / 30 bonds	-	0	30	0	30	0	30	-	-	AEC Q003
C3	Solderability	PC: 8 hours ± 15mins, Steam age (93°C ± 3°C / 100 % r.h) Solder Type: SnAgCu Test: Temp : 245°C±5°C, Dip Time : 5 ±0.5sec	3	15	-	0	15	0	15	0	15	-	-	JEDEC J-STD-002 Additional conditions: Solderability Test Wetting / Dewetting Dip & Look Pre-Test and Post Test 15pcs / 3 Test Conditions / 3 Lots
C4	Physical Dimensions		-	-	-	-	-	-	-	-	-	-	-	Monitoring by BE, reported in PPAP
C5	Solder Ball Shear		-	-	-	-	-	-	-	-	-	-	-	Not applicable: No Solder Ball Surface Mount Packaged (BGA) device
C6	Lead Integrity		-	-	-	-	-	-	-	-	-	-	-	Not applicable: No through-hole device
D1	Electromigration		-	-	-	-	-	-	-	-	-	-	-	Not applicable: Part of Technology Qualification
D2	Time Dependent Dielectric Breakdown		-	-	-	-	-	-	-	-	-	-	-	Not applicable: Part of Technology Qualification
D3	Hot Carrier Injection		-	-	-	-	-	-	-	-	-	-	-	Not applicable: Part of Technology Qualification
D4	Negative Bias Temperature Instability		-	-	-	-	-	-	-	-	-	-	-	Not applicable: Part of Technology Qualification
D6	Stress Migration		-	-	-	-	-	-	-	-	-	-	-	Not applicable: Part of Technology Qualification

**Infineon Technologies AG** **ATV QM**  
**Component Qualification Test Plan for Packaged Integrated Circuits**  
**according to AEC Q100 Rev. H**

Project	TDSO Subcon Plating at Syntronixs Asia (SA)	Date:	2021-06-15
Device no. for family qualification	TLE5014C16D, TLE4998C8D, TLE5309D E1211, TLE4999C8	Department:	IFAG ATV QM SC MSS
Chip no. for family qualification	M5014A, M4998L, M5009A (top) / M5109A (bottom), M4991A	Provided by:	L. Langkopf, S. Vasquez-Borucki, M. Schindler, F. Durrani
Device family	Linear Hall and Angle Sensor product families	Reviewed by:	J. Specht, F. Schröppel
Qualification no.	Q20ETS05		

TEST#	STRESS TEST according AEC Q100 Rev.H	Test conditions	# LOTS	Sample Size	Duration	Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Remarks
						Fail	Devices	Fail	Devices	Fail	Devices	Fail	Devices	
						TLE5014C16D M5014A		TLE4998C8D M4998L		TLE5309D E1211 M5009A (top) M5109A (bottom)		TLE4999C8 M4991A		
						Fail	Devices	Fail	Devices	Fail	Devices	Fail	Devices	
E1	Pre- and Post-Stress	Test to spec	4	all	-	0	all	0	all	0	all	0	all	Post-Stress: Refer to individual test
E2	Electrostatic Discharge Human Body Model ANSI/ESDA/JEDEC JS-001		-	3/voltage	-	-	-	-	-	-	-	-	-	Not applicable: No further failure mechanisms are expected with ESD HBM discharge types.
D1	Electromigration		-	-	-	-	-	-	-	-	-	-	-	Not applicable: Part of Technology Qualification
E3	Electrostatic Discharge Charged Device Model JESD22-C101	500V (all pins) 750 V (corner pins)	-	3/voltage	-	-	-	-	-	-	-	-	-	Not applicable: No further failure mechanisms are expected with ESD CDM discharge types.
E4	Latch-Up JESD 78	Ta = +150°C Vs = 5.5 V Itrigger = 150mA	-	6	-	-	-	-	-	-	-	-	-	Not applicable: No LU failure mechanisms are expected with package transfer project.
E5	Electrical Distributions AEC Q100-009	-40°C, 25°C, 125°C	4	30	-	0	30	0	30	0	30	0	30	
E12	Lead (Pb) Free		3	-	-	0	see remarks	0	see remarks	0	see remarks	-	-	AEC-Q005-Rev A: Solderability (refer to C3). Whisker test report available.
E12a	Lead (Pb) Free: Solderability		-	-	-	-	-	-	-	-	-	-	-	Referenced to # C3: Solderability
E12b	Lead (Pb) Free: Resistance to Solder Heat		-	-	-	-	-	-	-	-	-	-	-	SMD package: AEC Q005 states: It is strongly recommended that active SMT components not be attached by bottom-side wave solder processes. Full Body Immersion testing shall only be performed if requested by the user.



Infineon Technologies AG		Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev. H											ATV QM	
Project	TDSO Subcon Plating at Syntronixs Asia (SA)											Date:	2021-06-15	
Device no. for family qualification	TLE5014C16D, TLE4998C8D, TLE5309D E1211, TLE4999C8											Department:	IFAG ATV QM SC MSS	
Chip no. for family qualification	M5014A, M4998L, M5009A (top) / M5109A (bottom), M4991A											Provided by:	L. Langkopf, S. Vasquez-Borucki, M. Schindler, F. Durrani	
Device family	Linear Hall and Angle Sensor product families											Reviewed by:	J. Specht, F. Schröppel	
Qualification no.	Q20ETS05													
TEST#	STRESS TEST according AEC Q100 Rev.H	Test conditions	# LOTS	Sample Size	Duration	Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Part to be Qualified Fails/S.S.		Remarks
						TLE5014C16D M5014A		TLE4998C8D M4998L		TLE5309D E1211 M5009A (top) M5109A (bottom)		TLE4999C8 M4991A		
						Fail	Devices	Fail	Devices	Fail	Devices	Fail	Devices	
E12c	Lead (Pb) Free: Moisture Sensitivity		-	-	-	-	-	-	-	-	-	-	-	Referenced to # A1: Preconditioning
E12d	Lead (Pb) Free: Sn whisker testing		-	-	-	-	-	-	-	-	-	-	-	Refer to Whisker Test Report
F1	Process Average Testing		-	-	-	-	-	-	-	-	-	-	-	Implemented in production
F2	Statistical Bin/Yield Analysis		-	-	-	-	-	-	-	-	-	-	-	Implemented in production
G1-G4	Hermetic Package Tests		-	-	-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
G5	Package Drop		-	-	-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
G6	Lid Torque		-	-	-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
G7	Die Shear		-	-	-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
G8	Internal Water Vapor		-	-	-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
Supplier: Infineon Technologies AG														

<b>Infineon Technologies AG</b>	<b>Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev. H</b>	<b>ATV QM</b>
---------------------------------	--	---------------

Project	Torque sensor, TLE4999I	Date: 2021-06-15
Part for family qualification	TLE4999I	Department: ATV QM ATV SC MSS
Chip for family qualification	M4999	Provided by: V. Güngerich
Device family	Linear Hall	
Qualification no.	Q20ETS05	Reviewed by: F. Durrani

Part Operating Temperature Grade 0      -40°C to 150°C

**Family qualification (generic data) with structural similar (representative) types**

	Part	Chip	Chip size [ mm² ]	Wafer diameter [ mm ]	Wafer fab	Wafer technology	Package	Assembly line
Part to be Qualified	TLE4999I	M4999	1.00 x 2.20	200	Infineon Technologies AG, Dresden / Germany	SPT9_S	PG-SSO-3-12	Infineon Technologies Snd Bhd, Melaka / Malaysia

**Result:**                      **Qualification passed**

<b>Infineon Technologies AG</b>	<b>Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev.H</b>	<b>ATV QM</b>
---------------------------------	---	---------------

Project	Torque sensor, TLE4999i	Date: 2021-06-15
Device no. for family qualification	TLE4999i	Department: ATV QM ATV SC MSS
Chip no. for family qualification	M4999	Provided by: V. Güngerich
Device family	Linear Hall	
Qualification no.	Q20ETS05	Reviewed by: F. Durrani

TEST#	STRESS TEST	Test conditions	# Q-LOTS	Sample Size	Duration	Qualified parts (fails/ parts)		Qualified parts (fails/ parts)		Qualified parts (fails/ parts)		Remarks
						TLE4999i		TLE4999i		TLE4999i		
						Fails	Devices	Fails	Devices	Fails	Devices	
A1	Dip soldering	Ta = 260°C, 10 sec, 1x	1	480		0	308	0	308	0	308	DIP soldering JESD22-B102B
A2	Temperature Humidity Biased	Vs=5,5 V Ta = 85°C/85%r.h.	3	77	500h 1000h	0	77	0	77	0	77	acc. to Table 2, AEC Q100 Rev.H
A3	Unbiased Hast	Ta = 110°C / 85% r.h.	3	77	264h	0	77	0	77	0	77	acc. to Table 2, AEC Q100 Rev.H
A4	Temperature Cycling (Air to Air)	Ta = -55°C / +150°C	3	77	1000c 2000c	0	77	0	77	0	77	acc. to Table 2, AEC Q100 Rev.H
A6	High Temperature Storage Life (HTSL)	Ta = +175°C	3	77	500h 1000h 1500h	0	77	0	77	0	77	acc. to Table 2, AEC Q100 Rev.H
B1 B3	High Temperature Operating Life (HTOL) NVM Endurance, Data Retention, & Operational Life EDR 50 cycles @ 85°C Functional programming	Tjmax = +175°C Vdd = 7,0 V	3	77	500h 1000h 1500h 3000h	-	-	-	-	-	-	Not applicable: HTOL is not requested according to AEC Q100
B3	High Temperature Data Retention (HTDR) EDR 50 cycles @ 85°C Checkerboard	Ta = +175°C	3	77	500h 1000h 1500h	-	-	-	-	-	-	Not applicable: NVM Endurance test not related to plating process change.
B3	Low Temperature Data Retention (LTDR) EDR 50 cycles @ 55°C Checkerboard	Ta = 25°C	3	77	500h 1000h 1500h	-	-	-	-	-	-	Not applicable: NVM Endurance test not related to plating process change.

<b>Infineon Technologies AG</b>	<b>Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev.H</b>	<b>ATV QM</b>
---------------------------------	---	---------------

Project	Torque sensor, TLE4999i	Date: 2021-06-15
Device no. for family qualification	TLE4999i	Department: ATV QM ATV SC MSS
Chip no. for family qualification	M4999	Provided by: V. Güngerich
Device family	Linear Hall	
Qualification no.	Q20ETS05	Reviewed by: F. Durrani

TEST#	STRESS TEST	Test conditions	# Q-LOTS	Sample Size	Duration	Qualified parts (fails/ parts)		Qualified parts (fails/ parts)		Qualified parts (fails/ parts)		Remarks
						TLE4999i		TLE4999i		TLE4999i		
						Fails	Devices	Fails	Devices	Fails	Devices	
C1	Wire Bond Shear		3	5		0	5	0	5	0	5	acc. to Table 2, AEC Q100 Rev.H
C2	Wire Bond Pull		3	5		0	5	0	5	0	5	acc. to Table 2, AEC Q100 Rev. H MIL STD883, Method 2011
C3	Solderability		3	15		0	15	0	15	0	15	JESD22-B102B
C4	Physical Dimensions		3	10		0	10	0	10	0	10	JEDEC JESD22-B100
C6	Lead Integrity		3	10		-	-	-	-	-	-	Not applicable: Lead integrity test not related to plating process change.
D1	Electromigration		3	20/ condition	variable	-	-	-	-	-	-	Not applicable: part of Technology Qualification
D2	Time Depending Dielectric Breakdown		3	30/ condition	variable	-	-	-	-	-	-	Not applicable: part of Technology Qualification
D3	Hot Carrier Injection		3	15/ condition	variable	-	-	-	-	-	-	Not applicable: part of Technology Qualification
D4	Negative Bias Temperature Instability		3	15/ condition	variable	-	-	-	-	-	-	Not applicable: part of Technology Qualification
D5	Stress Migration		3	50/ condition	2000 h	-	-	-	-	-	-	Not applicable: part of Technology Qualification

<b>Infineon Technologies AG</b>	<b>Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev.H</b>	<b>ATV QM</b>
---------------------------------	---	---------------

Project	Torque sensor, TLE4999i	Date: 2021-06-15
Device no. for family qualification	TLE4999i	Department: ATV QM ATV SC MSS
Chip no. for family qualification	M4999	Provided by: V. Güngerich
Device family	Linear Hall	
Qualification no.	Q20ETS05	Reviewed by: F. Durrani

TEST#	STRESS TEST	Test conditions	# Q-LOTS	Sample Size	Duration	Qualified parts (fails/ parts)		Qualified parts (fails/ parts)		Qualified parts (fails/ parts)		Remarks
						TLE4999i		TLE4999i		TLE4999i		
						Fails	Devices	Fails	Devices	Fails	Devices	
E1	Pre- and Post-Stress	Test to spec	3	all	-	0	all	0	all	0	all	Post-Stress: refer to individual test
E2	Electrostatic Discharge Human Body Model	500 V 1000 V 2000 V 3000 V <b>4000 V</b> 5000 V	3	3/voltage		-	-	-	-	-	-	Not applicable: No further failure mechanisms are expected with ESD HBM discharge types.
E3	Electrostatic Discharge Charge Device Model	250 V 500 V <b>750 V</b> 1000V 1250 V 1500 V	3	3/voltage		-	-	-	-	-	-	Not applicable: No further failure mechanisms are expected with ESD CDM discharge types.
E4	Latch-Up		3	6		-	-	-	-	-	-	Not applicable: No LU failure mechanisms are expected with package transfer project.
E5	Electrical Distributions	-40°C, 25°C, 150°C	3	30		0	30	0	30	0	30	acc. to Table 2, AEC Q100 Rev.H
E12	Lead (Pb) Free		3	-	-	0	see remarks	0	see remarks	0	see remarks	AEC-Q005-Rev A: Solderability (refer to C3). Whisker test report are available.
E12a	Lead (Pb) Free: Solderability		-	-	-	-	-	-	-	-	-	referenced to # C3: Solderability
E12b	Lead (Pb) Free: Resistance to Solder Heat		-	-	-	-	-	-	-	-	-	referenced to # A1: DIP Soldering
E12c	Lead (Pb) Free: Moisture Sensitivity		n.a.	-	-	-	-	-	-	-	-	Through hole package
E12d	Lead (Pb) Free: Sn whisker testing		-	-	-	-	-	-	-	-	-	refer to Whisker Test Report

<b>Infineon Technologies AG</b>	<b>Component Qualification Test Plan for Packaged Integrated Circuits according to AEC Q100 Rev.H</b>	<b>ATV QM</b>
---------------------------------	---	---------------

Project	Torque sensor, TLE4999i	Date: 2021-06-15
Device no. for family qualification	TLE4999i	Department: ATV QM ATV SC MSS
Chip no. for family qualification	M4999	Provided by: V. Güngerich
Device family	Linear Hall	
Qualification no.	Q20ETS05	Reviewed by: F. Durrani

TEST#	STRESS TEST	Test conditions	# Q-LOTS	Sample Size	Duration	Qualified parts (fails/ parts)		Qualified parts (fails/ parts)		Qualified parts (fails/ parts)		Remarks
						TLE4999i		TLE4999i		TLE4999i		
						Fails	Devices	Fails	Devices	Fails	Devices	
F1	Process Average Testing		-	-	-	-	-	-	-	-	-	Implemented in production
F2	Statistical Bin/Yield Analysis		-	-	-	-	-	-	-	-	-	Implemented in production
G1-G4	Hermetic Package Tests		-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
G5	Package Drop		-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
G6	Lid Torque		-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
G7	Die Shear		-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device
G8	Internal Water Vapor		-	-	-	-	-	-	-	-	-	Not applicable: No hermetic package device



Sales name	SP number	OPN	Package
TLE4997A8	SP000902756	TLE4997A8XUMA1	PG-TDSO-8-1
TLE4997A8D	SP000902760	TLE4997A8DXUMA1	PG-TDSO-8-2
TLE4997A8D E0300	SP001115196	TLE4997A8DE0300XUMA1	PG-TDSO-8-2
TLE4998C8	SP000902764	TLE4998C8XUMA1	PG-TDSO-8-1
TLE4998C8	SP002497758	TLE4998C8XUMA2	PG-TDSO-8-1
TLE4998C8D	SP000902768	TLE4998C8DXUMA1	PG-TDSO-8-2
TLE4998C8D	SP002497754	TLE4998C8DXUMA2	PG-TDSO-8-2
TLE4998P8	SP000902772	TLE4998P8XUMA1	PG-TDSO-8-1
TLE4998P8D	SP000902776	TLE4998P8DXUMA1	PG-TDSO-8-2
TLE4998S8	SP000902780	TLE4998S8XUMA1	PG-TDSO-8-1
TLE4998S8D	SP000902784	TLE4998S8DXUMA1	PG-TDSO-8-2
TLE4999C8	SP002662500	TLE4999C8XUMA1	PG-TDSO-8-1
TLE4999I3	SP001689862	TLE4999I3XALA1	PG-SSO-3-12
TLE4999I3T-E81	SP001710670	TLE4999I3TE81XALA1	PG-SSO-3-12
TLE5009A16 E1200	SP001285624	TLE5009A16E1200XUMA1	PG-TDSO-16-1
TLE5009A16 E1210	SP001296110	TLE5009A16E1210XUMA1	PG-TDSO-16-1
TLE5009A16 E2200	SP001296118	TLE5009A16E2200XUMA1	PG-TDSO-16-1
TLE5009A16 E2210	SP001296114	TLE5009A16E2210XUMA1	PG-TDSO-16-1
TLE5009A16D E1200	SP001285628	TLE5009A16DE1200XUMA1	PG-TDSO-16-2
TLE5009A16D E1210	SP001296122	TLE5009A16DE1210XUMA1	PG-TDSO-16-2
TLE5009A16D E2200	SP001296126	TLE5009A16DE2200XUMA1	PG-TDSO-16-2
TLE5009A16D E2210	SP001296130	TLE5009A16DE2210XUMA1	PG-TDSO-16-2
TLE5012BD E1200	SP001205296	TLE5012BDE1200XUMA1	PG-TDSO-16-2
TLE5012BD E9200	SP001205300	TLE5012BDE9200XUMA1	PG-TDSO-16-2
TLE5014C16	SP001231806	TLE5014C16XUMA1	PG-TDSO-16-1
TLE5014C16D	SP001410042	TLE5014C16DXUMA1	PG-TDSO-16-2
TLE5014C16D E0015	SP002555212	TLE5014C16DE0015XUMA1	PG-TDSO-16-2
TLE5014P16	SP001231814	TLE5014P16XUMA1	PG-TDSO-16-1
TLE5014P16D	SP001673472	TLE5014P16DXUMA1	PG-TDSO-16-2
TLE5014S16	SP001231818	TLE5014S16XUMA1	PG-TDSO-16-1
TLE5014S16D	SP001410046	TLE5014S16DXUMA1	PG-TDSO-16-2
TLE5014SP16	SP002460060	N.A.	PG-TDSO-16-1
TLE5014SP16 E0001	SP004232096	TLE5014SP16E0001XUMA1	PG-TDSO-16-1
TLE5014SP16 E0002	SP004531446	TLE5014SP16E0002XUMA1	PG-TDSO-16-1
TLE5014SP16D E0002	SP004531452	TLE5014SP16DE0002XUMA1	PG-TDSO-16-2
TLE5109A16 E1210	SP000956970	TLE5109A16E1210XUMA1	PG-TDSO-16-1
TLE5109A16 E2210	SP000956966	TLE5109A16E2210XUMA1	PG-TDSO-16-1
TLE5109A16D E1210	SP001496434	TLE5109A16DE1210XUMA1	PG-TDSO-16-2
TLE5109A16D E2210	SP001044230	TLE5109A16DE2210XUMA1	PG-TDSO-16-2
TLE5309D E1211	SP001227880	TLE5309DE1211XUMA1	PG-TDSO-16-2
TLE5309D E2211	SP001227888	TLE5309DE2211XUMA1	PG-TDSO-16-2
TLE5309D E5201	SP001227884	TLE5309DE5201XUMA1	PG-TDSO-16-2