LPTM10 New Mask Set Yield and Parametric Analysis

November 2015

The LPTM10 (also known as Platform Manager) is a dual-die power manager product that consists of a LCMXO640C and ispPAC-POWR1220AT8.

Changes were made to each of the respective die that needed to be validated for use in the LPTM10. Those changes were:

1. LCMXO product family was transferred from Fujitsu's 200mm Mie fab to the adjacent 300mm fab. This change was detailed in PCN 05A-14. on June 9, 2014.
2. The ispPAC-POWR1220AT8 and other POWR devices were dual sourced from UMC to the Seiko-Epson fab in Sakata, Japan. This change was detailed in PCN 01A-12 on January 23, 2012
3. Additionally, the mold compound for the TQFP version was changed.

The above changes have been designated as LPTM10 design revision "B". An engineering build incorporating all the above changes was built and characterized. This report is a summary of those findings.

PRODUCT SUMMARY

Product-Package-Revision	Package (Mold Compound)	LCMXO640C	ispPAC-POWR1220AT8
LPTM10-12107 “A”	208ftBGA	LCMXO640C (200mm)	ispPAC-POWR1220AT8 (UMC)
LPTM10-12107 “B”	208ftBGA (no change)	LCMXO640C (300mm)	ispPAC-POWR1220AT8 (Seiko)
LPTM10-1247 “A”	128TQFP CEL-9510HFL-U	LCMXO640C (200mm)	ispPAC-POWR1220AT8 (UMC)
LPTM10-1247 “B”	128TQFP Sumitomo EME-G631SH	LCMXO640C (300mm)	ispPAC-POWR1220AT8 (Seiko)

SUMMARY OF RESULTS / FINDINGS

				Class Test #1			Class Test #1	
Device Name	**Package**	**Mask Set**	**Lot #**	**Tester**	**Qty In**	**Yield**	**Tester**	**Yield**
LPTM10-12107	208BGA	B New	CX4123AE1	Nextest	2417	1.006	Eagle	1.021
		A Old	Production Average		20655	1.000	Eagle	1.000
LPTM10-1247	128TQFP	B New	CX4122AZE1	Nextest	2424	1.001	Eagle	1.006
		A Old	Production Average		7660	1.000	Eagle	1.000

- Test yields are slightly better for the rev B die combination for both package types.

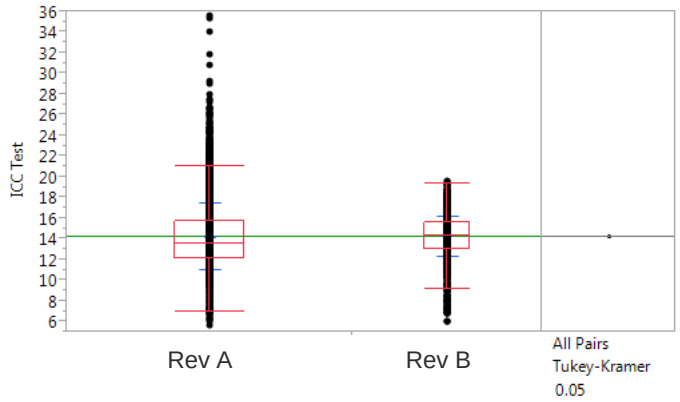
				Nextest				Eagle							
				Icc		Tpd		Icc		ILeak 5.5 VMON		ILeak 14V od HV		HV VP 12V	
Device Name	**Package**	**Mask Set**	**Lot #**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**	**Mean**	**StdDev**
LPTM10-12107	208BGA	B New	CX4123AE1	14.28	1.91	36326	570.56	32.49	0.35	83.22	1.28	45.57	0.6	11.93	0.05
		A Old	Production Average	14.29	3.25	35895	1313.89	33.37	0.43	92.15	1.38	45.68	1.26	11.96	0.05
LPTM10-1247	128TQFP	B New	CX4122AZE1	14.82	1.09	35055	474.71	32.94	0.39	86.02	1.4	47.11	0.66	11.94	0.04
		A Old	Production Average	17.02	3.63	34881	1358.04	33.63	0.46	94.74	1.04	45.67	0.66	11.92	0.05

- Critical Parametric comparison shows that new rev B die combination has better Mean and STDev compared to old/current rev A die combination.
  Results suggest that we can release rev B to production.

ONEWAY ANALYSIS – PARAMETRIC TEST

NEXTEST TESTER – FTG208

Oneway Analysis of ICC Test By Lot



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	5.65	11.1166	12.15975	13.488	15.7	18.938	35.675
Rev B	5.987	12.2724	13.038	14.287	15.625	16.575	19.625

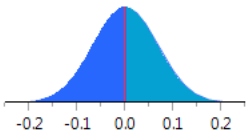
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	3582	14.2852	3.25349	0.05436	14.179	14.392
Rev B	2367	14.2829	1.91439	0.03935	14.206	14.360

t Test

Assuming unequal variances

Difference	-0.00232	t Ratio	-0.03451
Std Err Dif	0.06711	DF	5875.383
Upper CL Dif	0.12924	Prob > |t|	0.9725
Lower CL Dif	-0.13387	Prob > t	0.5138
Confidence	0.95	Prob < t	0.4862



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

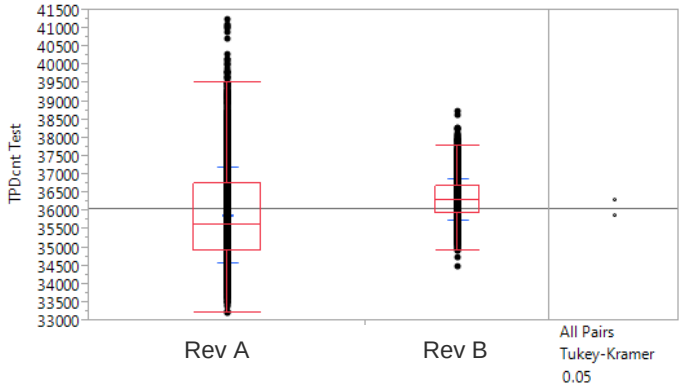
q*	Alpha
1.96036	0.05

LSD Threshold Matrix

Abs(Dif)-HSD	Rev A	Rev B
01B Mask Set Lot	-0.12964	-0.14301
02A Mask Set Lot	-0.14301	-0.15947

Positive values show pairs of means that are significantly different.

Oneway Analysis of TPDcnt Test By Lot



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	33221	34417.6	34895.75	35610	36755.25	37827.1	41238
Rev B	34482	35629.4	35936	36302	36678	37076.6	38738

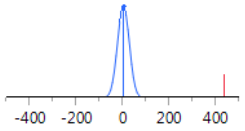
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	3582	35895.4	1313.89	21.953	35852	35938
Rev B	2367	36326.2	570.56	11.727	36303	36349

t Test

Assuming unequal variances

Difference	430.793	t Ratio	17.30842
Std Err Dif	24.889	DF	5267.218
Upper CL Dif	479.586	Prob > |t|	<.0001*
Lower CL Dif	381.999	Prob > t	<.0001*
Confidence	0.95	Prob < t	1.0000



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96036	0.05

LSD Threshold Matrix

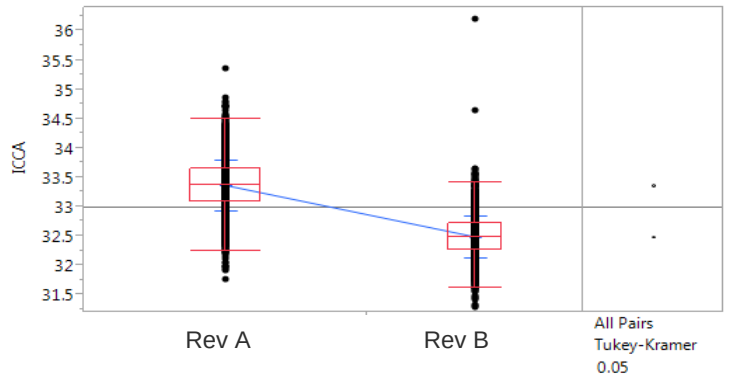
Abs(Dif)-HSD	Rev B	Rev A
02A Mask Set Lot	-61.61	374.65
01B Mask Set Lot	374.65	-50.08

Positive values show pairs of means that are significantly different.

ONEWAY ANALYSIS – PARAMETRIC TEST

ETS TESTER – FTG208

Oneway Analysis of ICCA By Lot



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	31.766	32.8113	33.08875	33.364	33.65525	33.9107	35.361
Rev B	31.287	32.055	32.258	32.4865	32.718	32.934	36.208

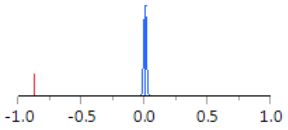
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	3082	33.3696	0.432993	0.00780	33.354	33.385
Rev B	2354	32.4910	0.354625	0.00731	32.477	32.505

t Test

Assuming unequal variances

Difference	-0.87853	t Ratio	-82.1901
Std Err Dif	0.01069	DF	5407.682
Upper CL Dif	-0.85758	Prob > |t|	<.0001*
Lower CL Dif	-0.89949	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96040	0.05

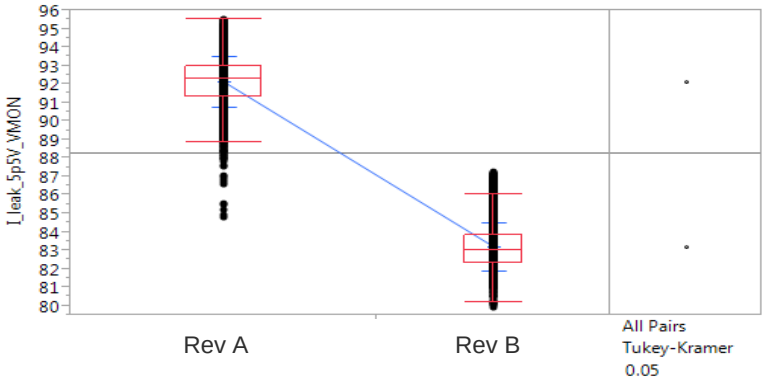
LSD Threshold Matrix

Abs(Dif)-HSD

	Rev A	Rev B
01B Mask Set Lot	-0.02002	0.85702
02A Mask Set Lot	0.85702	-0.02291

Positive values show pairs of means that are significantly different.

Oneway Analysis of I_leak_5p5V_VMON By Lot



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	84.822	90.3553	91.3115	92.268	93.006	93.8212	95.529
Rev B	79.925	81.8255	82.3385	82.983	83.821	85.054	87.244

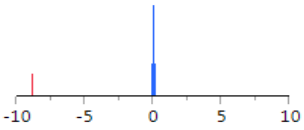
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	3082	92.1470	1.38408	0.02493	92.098	92.196
Rev B	2354	83.2197	1.28494	0.02648	83.168	83.272

t Test

Assuming unequal variances

Difference	-8.9274	t Ratio	-245.444
Std Err Dif	0.0364	DF	5232.828
Upper CL Dif	-8.8561	Prob > |t|	<.0001*
Lower CL Dif	-8.9987	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96040	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

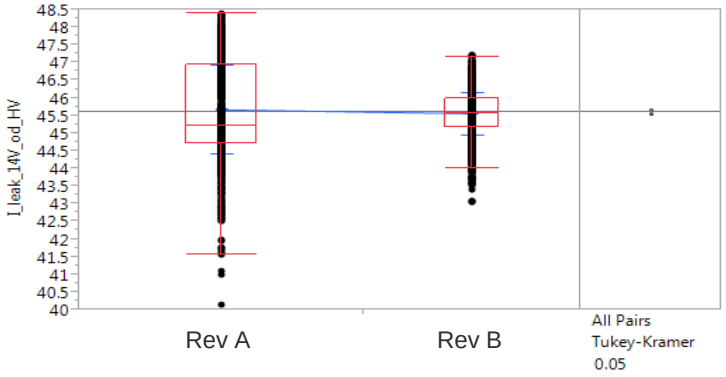
	Rev A	Rev B
01B Mask Set Lot	-0.0670	8.8554
02A Mask Set Lot	8.8554	-0.0767

Positive values show pairs of means that are significantly different.

ONEWAY ANALYSIS – PARAMETRIC TEST

ETS TESTER – FTG208

Oneway Analysis of I_leak_14V_od_HV By Lot



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	40.151	44.3723	44.71775	45.1915	46.94725	47.3984	48.409
Rev B	43.04	44.873	45.18475	45.578	45.973	46.3255	47.218

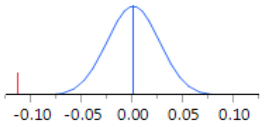
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	3082	45.6795	1.26022	0.02270	45.635	45.724
Rev B	2354	45.5654	0.59671	0.01230	45.541	45.589

t Test

Assuming unequal variances

Difference	-0.11415	t Ratio	-4.42154
Std Err Dif	0.02582	DF	4632.594
Upper CL Dif	-0.06354	Prob > |t|	<.0001*
Lower CL Dif	-0.16477	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96040	0.05

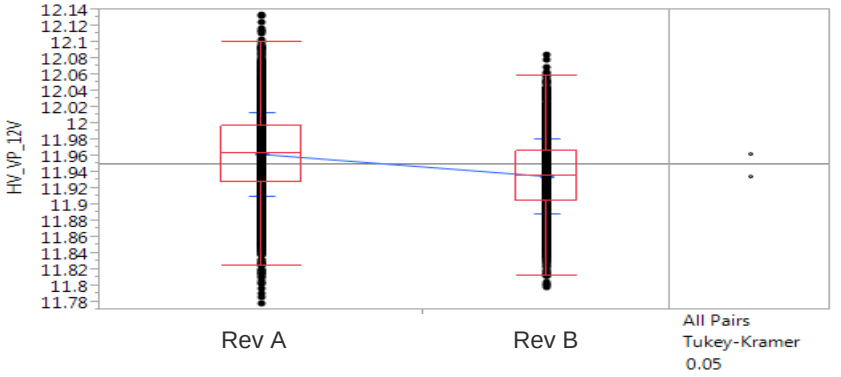
LSD Threshold Matrix

Abs(Dif)-HSD

	Rev A	Rev B
01B Mask Set Lot	-0.05129	0.05905
02A Mask Set Lot	0.05905	-0.05868

Positive values show pairs of means that are significantly different.

Oneway Analysis of HV_VP_12V By Lot



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	11.77704	11.89734	11.92729	11.96201	11.99728	12.02847	12.13406
Rev B	11.79737	11.87451	11.90412	11.93465	11.96605	11.994	12.08416

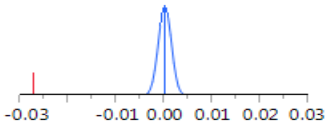
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	3082	11.9622	0.051511	0.00093	11.960	11.964
Rev B	2354	11.9349	0.046079	0.00095	11.933	11.937

t Test

Assuming unequal variances

Difference	-0.02730	t Ratio	-20.5618
Std Err Dif	0.00133	DF	5300.543
Upper CL Dif	-0.02470	Prob > |t|	<.0001*
Lower CL Dif	-0.02990	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96040	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

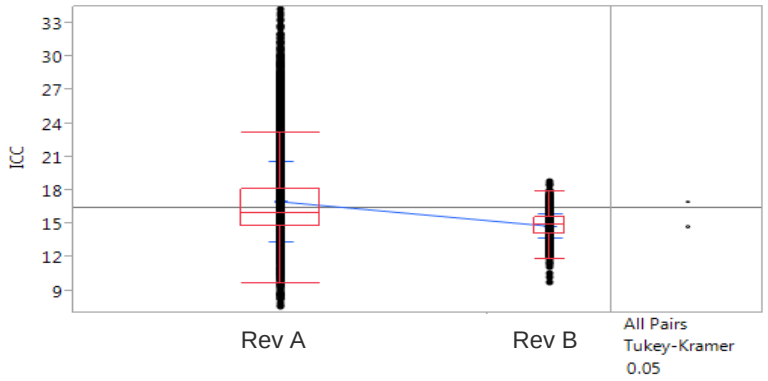
	Rev A	Rev B
01B Mask Set Lot	-0.00246	0.02466
02A Mask Set Lot	0.02466	-0.00281

Positive values show pairs of means that are significantly different.

ONEWAY ANALYSIS – PARAMETRIC TEST

NEXTEST TESTER – TG128

Oneway Analysis of ICC By Mask Set



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	7.575	13.85	14.75	15.9	18.125	22.6565	34.225
Rev B	9.775	13.375	14.063	14.887	15.619	16.125	18.813

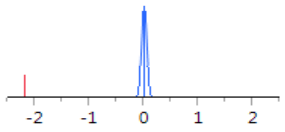
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	7504	17.0220	3.62949	0.04190	16.940	17.104
Rev B	2245	14.8235	1.09335	0.02308	14.778	14.869

t Test

Assuming unequal variances

Difference	-2.1985	t Ratio	-45.9628
Std Err Dif	0.0478	DF	9746.655
Upper CL Dif	-2.1048	Prob > |t|	<.0001*
Lower CL Dif	-2.2923	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96021	0.05

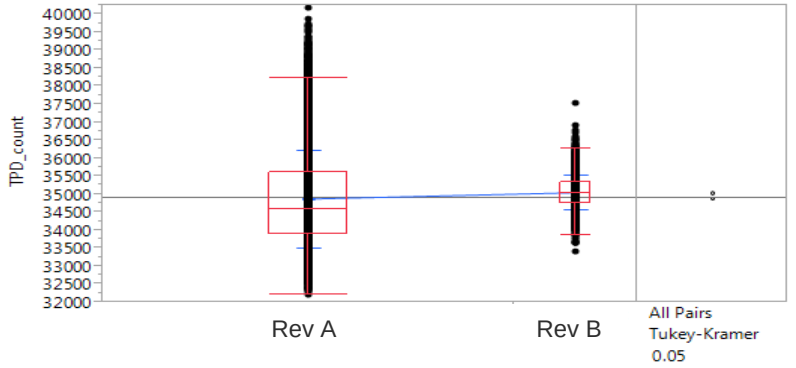
LSD Threshold Matrix

Abs(Dif)-HSD

	Rev A	Rev B
01B Mask Set Lot	-0.1033	2.0463
02A Mask Set Lot	2.0463	-0.1888

Positive values show pairs of means that are significantly different.

Oneway Analysis of TPD_count By Mask Set



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	32214	33415	33886	34561.5	35624.75	36964	40177
Rev B	33400	34456.6	34740.5	35042	35350	35674	37542

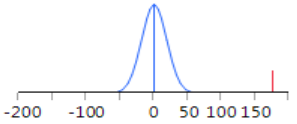
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	7504	34880.9	1358.04	15.677	34850	34912
Rev B	2245	35055.7	474.71	10.019	35036	35075

t Test

Assuming unequal variances

Difference	174.723	t Ratio	9.391088
Std Err Dif	18.605	DF	9554.434
Upper CL Dif	211.193	Prob > |t|	<.0001*
Lower CL Dif	138.252	Prob > t	<.0001*
Confidence	0.95	Prob < t	1.0000



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96021	0.05

LSD Threshold Matrix

Abs(Dif)-HSD

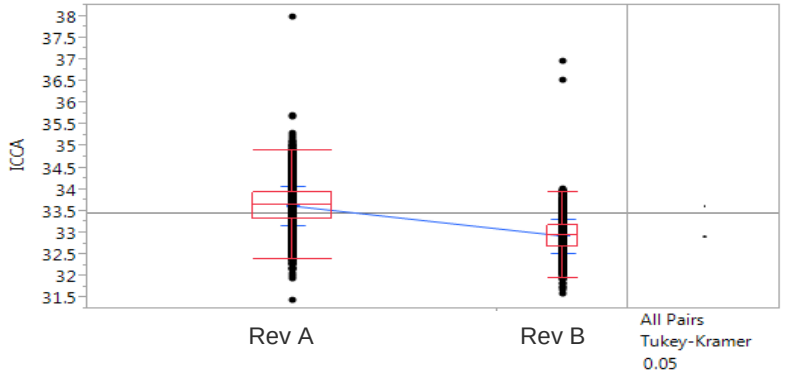
	Rev B	Rev A
02A Mask Set Lot	-70.97	117.52
01B Mask Set Lot	117.52	-38.82

Positive values show pairs of means that are significantly different.

ONEWAY ANALYSIS – PARAMETRIC TEST

ETS TESTER – TG128

Oneway Analysis of ICCA By Mask Set



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	31.455	33.035	33.315	33.63	33.946	34.215	38.002
Rev B	31.603	32.4575	32.683	32.9345	33.181	33.4115	36.96

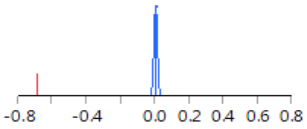
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	6639	33.6286	0.460949	0.00566	33.618	33.640
Rev B	2104	32.9362	0.389004	0.00848	32.920	32.953

t Test

Assuming unequal variances

Difference	-0.69245	t Ratio	-67.9245
Std Err Dif	0.01019	DF	4131.801
Upper CL Dif	-0.67246	Prob > |t|	<.0001*
Lower CL Dif	-0.71244	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

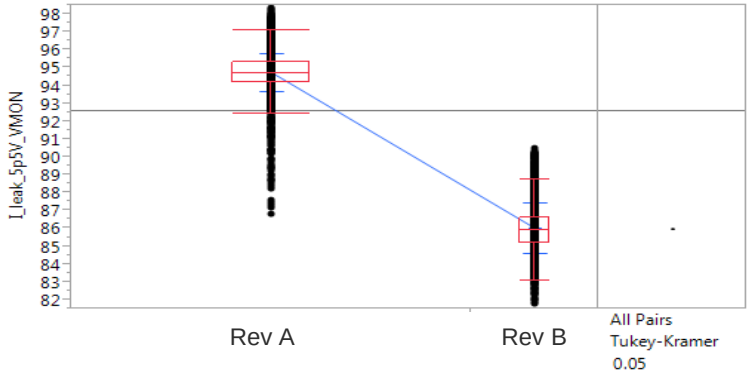
q*	Alpha
1.96024	0.05

LSD Threshold Matrix

Abs(Dif)-HSD	Rev A	Rev B
01B Mask Set	-0.01513	0.67064
02A Mask Set	0.67064	-0.02688

Positive values show pairs of means that are significantly different.

Oneway Analysis of I_leak_5p5V_VMON By Mask Set



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	86.822	93.662	94.157	94.658	95.326	96.02	98.388
Rev B	81.758	84.4915	85.16575	85.8645	86.59675	87.9735	90.483

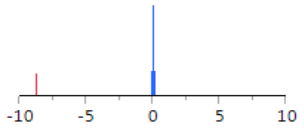
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	6639	94.7436	1.03568	0.01271	94.719	94.768
Rev B	2104	86.0189	1.40378	0.03060	85.959	86.079

t Test

Assuming unequal variances

Difference	-8.7247	t Ratio	-263.28
Std Err Dif	0.0331	DF	2864.13
Upper CL Dif	-8.6597	Prob > |t|	<.0001*
Lower CL Dif	-8.7897	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001*



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96024	0.05

LSD Threshold Matrix

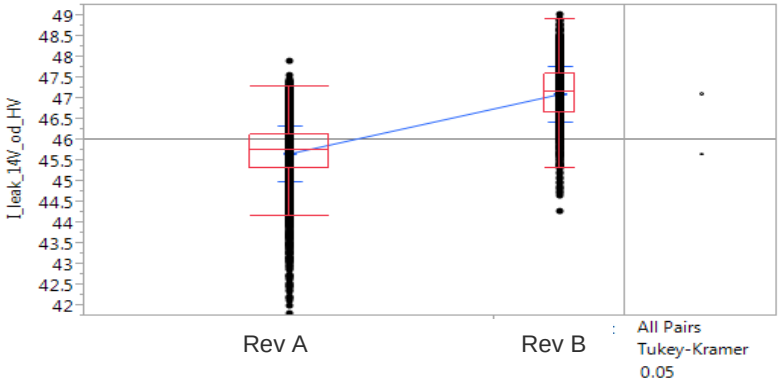
Abs(Dif)-HSD	Rev A	Rev B
01B Mask Set	-0.0386	8.6690
02A Mask Set	8.6690	-0.0686

Positive values show pairs of means that are significantly different.

ONEWAY ANALYSIS – PARAMETRIC TEST

ETS TESTER – TG128

Oneway Analysis of I_leak_14V_od_HV By Mask Set



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	41.817	44.868	45.325	45.747	46.111	46.434	47.915
Rev B	44.281	46.2825	46.655	47.1425	47.57875	47.9595	49.025

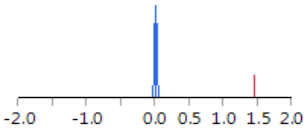
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	6639	45.6784	0.664952	0.00816	45.662	45.694
Rev B	2104	47.1157	0.665128	0.01450	47.087	47.144

t Test

Assuming unequal variances

Difference	1.43727	t Ratio	86.37822
Std Err Dif	0.01664	DF	3533.907
Upper CL Dif	1.46989	Prob > |t|	<.0001*
Lower CL Dif	1.40464	Prob > t	<.0001*
Confidence	0.95	Prob < t	1.0000



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

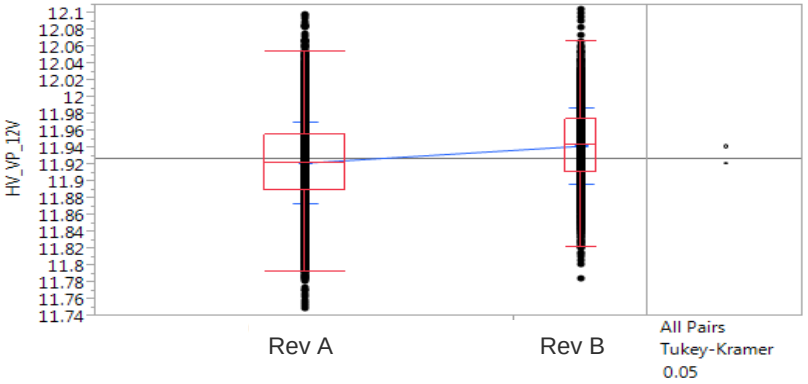
q*	Alpha
1.96024	0.05

LSD Threshold Matrix

Abs(Dif)-HSD	Rev B	Rev A
02A Mask Set	-0.0402	1.4047
01B Mask Set	1.4047	-0.0226

Positive values show pairs of means that are significantly different.

Oneway Analysis of HV_VP_12V By Mask Set



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
Rev A	11.74972	11.85974	11.88895	11.92248	11.95509	11.9856	12.09907
Rev B	11.78468	11.88443	11.91143	11.94354	11.97396	12.00134	12.10559

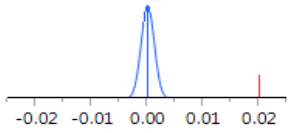
Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
Rev A	6639	11.9227	0.049298	0.00061	11.921	11.924
Rev B	2104	11.9428	0.045525	0.00099	11.941	11.945

t Test

Assuming unequal variances

Difference	0.020087	t Ratio	17.28105
Std Err Dif	0.001162	DF	3790.649
Upper CL Dif	0.022366	Prob > |t|	<.0001*
Lower CL Dif	0.017808	Prob > t	<.0001*
Confidence	0.95	Prob < t	1.0000



Means Comparisons

Comparisons for all pairs using Tukey-Kramer HSD

Confidence Quantile

q*	Alpha
1.96024	0.05

LSD Threshold Matrix

Abs(Dif)-HSD	Rev B	Rev A
02A Mask Set	-0.00293	0.01771
01B Mask Set	0.01771	-0.00165

Positive values show pairs of means that are significantly different.

CONCLUSION

Since the two die that make up the LPTM10 have been previously characterized and released, it was highly likely that the combination were also production-worthy.

An analysis of yield and parametric data from two engineering builds confirms that the LPTM10 operates within expected parameters. Rev ”B” seems to have slightly better mean parametric values and tighter standard deviations but the difference is not statistically significant.

The LPTM10 “B” mask set is recommended for production release.