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## Physical Layer Integrated Circuits

### Reliability Data

**HDMP-1012/1014/1022/1024/  
1512/1514/1526/1536/1546/  
1536A/1546A/1636/1646/  
0451**

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This reliability data sheet covers a range of integrated circuits fabricated in the HP-25 high speed bipolar process, and packaged either in the MQUAD™ high power package or in standard or thermally enhanced PQFPs. Both process and package reliability data is presented. For reference, the HDMP-1012/1014/1022/1024/1512/1514 are packaged in MQUAD 14x20mm 80 pin packages. The 1526 is packaged in a 14x14mm 64 pin EDQUAD™ package. The remainder of the units are packaged in 10x10mm or 14x14mm standard PQFPs, all 64 pins except for the 44 pin HDMP-0451.

### HP25 Process Reliability

**Table 1: Failure Rate Prediction ( $E_a = 0.7eV$ )**

$T_j$ (°C)	Point		90% Confidence	
	MTTF (hrs/failure)	FITs (fail/10 <sup>9</sup> hrs)	MTTF (hrs/failure)	FITs (fail/10 <sup>9</sup> hrs)
150	936,000	1,068	468,000	2,137
125	3,126,000	320	1,563,000	640
100	12,270,000	81	6,136,000	163
90	22,360,000	45	11,180,000	89
85	30,560,000	33	15,280,000	65
80	42,130,000	24	21,070,000	47
75	58,640,000	17	29,320,000	34
70	82,400,000	12	41,200,000	24
65	117,000,000	9	58,480,000	17
60	167,800,000	6	83,880,000	12
55	243,300,000	4	121,600,000	8
50	356,900,000	3	178,500,000	6
45	530,000,000	2	265,000,000	4
40	796,900,000	1	398,500,000	3
35	1,214,000,000	0.8	607,200,000	2
30	1,876,000,000	0.5	938,100,000	1
25	2,942,000,000	0.3	1,471,000,000	0.7

## Process Reliability and Failure Rate Prediction

The process reliability is derived from high temperature operating life testing of multiple lots of four IC qual vehicles of far greater complexity and power dissipation than these physical layer ICs, a total of 1373 units at junction temperatures from 150 to 230°C. The Arrhenius model predicts reduced failure rates at reduced temperatures. The activation energy of 0.7eV was chosen based on the reliability qualification and monitor experience of the quality and reliability engineers who sustain this bipolar fabrication process and other sources.

Following is a list of qualification tests for each active part. All of the plastic packaged parts underwent IR reflow preconditioning before high temperature operating life test. The preconditioning consisted of a 16-24 hour 125°C bake followed by either 2 or 3 passes through IR reflow per EIAJ-ED-4701, TM A-133, condition I-A.

## Trademarks

MQUAD™ is a trademark of Olin Corporation. EDQUAD™ is a trademark of ASAT Inc.

**Table 2: Reliability Results Summary - 1526 (HP25/EDQUAD PQFP)**

Test name/Test method	Qty	# rej/duration	LTPD
High Temperature Operating Life, $T_a=85^\circ\text{C}$ , $T_j=150^\circ\text{C}$ , $V_{cc} = 3.3\text{V}$	35	0/2000hr	6%

**Table 3: Reliability Results Summary - 1536/1546 (HP25/PQFP)**

Test name/Test method	Qty	# rej/duration	LTPD
High Temperature Operating Life, $T_a=85^\circ\text{C}$ , $T_j=150^\circ\text{C}$ , $V_{cc} = 3.3\text{V}$	190	0/1000hr	1.3%

**Table 4: Reliability Res. Summary - 1536A/1546A/1636/1646 (HP25/PQFP)**

Test name/Test method	Qty	# rej/duration	LTPD
High Temperature Operating Life $T_a=85^\circ\text{C}$ , $T_j=150^\circ\text{C}$ , $V_{cc} = 3.3\text{V}$	40 (10x10mm)	0/1000hr	3%
High Temperature Operating Life $T_a=85^\circ\text{C}$ , $T_j=150^\circ\text{C}$ , $V_{cc} = 3.3\text{V}$	40 (14x14mm)	0/1000hr	3%

**Table 5: Reliability Results Summary – HDMP-0451 (HP25/PQFP)**

Test name/Test method	Qty	# rej/duration	LTPD
High Temperature Operating Life $T_a=85^\circ\text{C}$ , $T_j=150^\circ\text{C}$ , $V_{cc} = 3.3\text{V}$	40 (10x10mm)	0/1000hr	~5%

**Table 6: Reliability Results Summary - 1512/1514 (HP25/MQUAD)**

Test name/Test method	Qty	# rej/duration	LTPD
High Temperature Operating Life $T_a=85^{\circ}\text{C}$ , $T_j=150^{\circ}\text{C}$ , $V_{cc} = 3.3\text{V}$	40 10x10mm	0/1000hr	~5%

**Table 7: Reliability Results Summary – HDMP-1022/1024 (HP25/MQUAD)**

Test name/Test method	Qty	# rej/duration	LTPD
High Temperature Operating Life $T_a=85^{\circ}\text{C}(\text{Tx})$ , $T_a=55^{\circ}\text{C}(\text{Rx})$ , $T_j=150^{\circ}\text{C}$ , $V_{cc} = 5.5\text{V}$	49 (-1022 Tx)	0/1000hr	<3%
High Temperature Operating Life $T_a=85^{\circ}\text{C}(\text{Tx})$ , $T_a=55^{\circ}\text{C}(\text{Rx})$ , $T_j=150^{\circ}\text{C}$ , $V_{cc} = 5.5\text{V}$	50 (-1024 Rx)	0/1000hr	<3%

**Environmental/Mechanical Tests - HP25 in PQFP****Table 8: Environmental Tests - All HP25/PQFP (Family basis)**

Test name	MIL-STD-883 Reference	Test Conditions	Qty	# rej	LTPD
Temp Cycle		$-65^{\circ}\text{C}/+150^{\circ}\text{C}$ , 15min dwell (air-to-air), 1000 cycles	40	0	~5%
Pressure Pot		$121^{\circ}\text{C}$ , 100% RH (no bias), 168 hr	40	0	~5%
Thermal Shock	1011.9 Cond. B	$-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$ , 200 cycles, liquid/liquid	11 (10x10mm) 11 (14x14mm)	0	10%

**Table 9: Environmental Tests - All HP25/PQFP (Family basis)**

Test name	MIL-STD-883 Reference	Test Conditions	Qty	Description	# rej
Package Integrity Sequence			90		0
Preconditioning		3 passes of IR reflow at $T_{max} = 235^{\circ}\text{C}$ , 84 hr $30^{\circ}\text{C}/60\%\text{RH}$ (no bias)	45	10x10mm	0
		NOTE: Although the package has been qualified to moisture level 3 by the e package vendor, HP intends to conservatively rate this package to level 4.	45	14x14mm	0
Mechanical Shock	2002.3/cond A	500g, 0.5ms, 5 impacts/axis	45	10x10mm	0
			45	14x14mm	0
Vibration	2007.2/cond A	20g, 20-2,000 Hz, 4 cycles/axis	45	10x10mm	0
			45	14x14mm	0
Temp Cycle		$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$ , 1000 cycles	22	10x10mm	0
			23	14x14mm	0
Pressure Pot		$121^{\circ}\text{C}$ , 100% RH, no bias, 168 hrs	23	10x10mm	0
			22	14x14mm	0

**Table 10: Mechanical Tests-All HP25/PQFP (Family basis)**

Test name	MIL-STD-883 Reference	Test Conditions	Qty	# rej	LTPD
Resistance to solvents - Pkg vendor data	2015.8	Solvent A	22	0	10%
		Solvent B	22	0	10%
		Solvent C	22	0	10%
Solderability - Pkg vendor data		$219^{\circ}\text{C}/5\text{sec}$ , 8 hours steam aging	22	0	10%
Lead Integrity - Pkg vendor data		$90^{\circ}$ bend, 3 oz., 3 cycle, 5 leads, 11 units	11	0	20%

## Environmental/Mechanical Tests - HP25 in MQUAD

**Table 11: Environmental Tests - All HP25/MQUAD (Family basis)**

Test name	MIL-STD-883 Reference	Test Conditions	Qty	# rej	LTPD
Solder Heat Resistance		(260°C +/-10°C, 10 sec)	12	0	20%
IR Reflow Heat Resistance		IR reflow per EIAJ-ED-4701, TM A-133, cond I-A	12	0	20%
Env Test Sequence:			22	0	10%
- Mechanical Shock	2002.3 Cond.B	1500g, 0.5ms, 5 impacts/axis			
- Vibration, Variable Frequency	2007.2 Cond.A	20g, 20-2000Hz, 4 cycles/axis			
- Temperature Cycle (air-to-air)		-40°C/+130°C, 10min dwell, 100 cycle			
- Thermal Shock (sand-to-sand)		-40°C/+130°C, 5min dwell, 100 cycle			

**Table 12: Mechanical Tests - All HP25/MQUAD (Family basis)**

Test name	MIL-STD-883 Reference	Test Conditions	Qty	# rej
Resistance to solvents	2015.8	Solvent A	5	0
		Solvent B	5	0
		Solvent D	5	0
Solderability	2003.7	8 hours steam aging 10 leads/device randomly selected for visual inspection	5	0
Destructive Bond Pull Post-seal (after decap)	2011.7	Condition D (wire pull-double bond) Every available wire pulled)	2	0
Destructive Bond Pull Pre-seal (In-Process)	2011.7	Condition D (wire pull-double bond) 20 wires/unit pulled	4	0
Ball Shear		10 balls/unit sheared	4	0
Die Shear Strength	2019.5		5	0

**Table 13: Electrostatic Discharge Sensitivity Classification**

<b>Test name</b>	<b>MIL-STD-883 Reference</b>	<b>Test Conditions</b>	<b>Qty</b>	<b>Description</b>	<b>Pass Level</b>
ESD Classification	3015	Human Body Model	15	HDMP-1536A/1546A/1636/1646/0451; revs 4.0 or greater of HDMP-1536/1546	2kV
	3015	Human Body Model	15	HDMP-1536/1546	Revs earlier than 4.0: pass200V, fail 500V
	3015	Human Body Model	15	HDMP-1526	1000V
	3015	Human Body Model	15	HDMP-1512/1514	500V (laser I/O pins); 1000V (all others)
	3015	Human Body Model	15	HDMP-1022/1024	pass500V, fail 1000V
ESD Classification		Machine Model per EIAJ#1988.3.2B, Version 2, C=200pF, R=0	15	HDMP-1536/1546	Revs earlier than 4.0: pass 100V, fail 150V