



PRODUCT/PROCESS CHANGE NOTIFICATION

PCN APG-ABD/13/8272

Dated 27 Dec 2013

VNQ5E250AJ-E, VNH5050ATR-E, VNH5180ATR-E:Copper Wire Implementation

Table 1. Change Implementation Schedule

Forecasted implementation date for change	30-Jun-2014
Forecasted availability date of samples for customer	31-Mar-2014
Forecasted date for STMicroelectronics change Qualification Plan results availability	20-Dec-2013
Estimated date of changed product first shipment	30-Jun-2014

Table 2. Change Identification

Product Identification (Product Family/Commercial Product)	VNQ5E250AJ-E, VNH5050ATR-E, VNH5180ATR-E
Type of change	Package assembly material change
Reason for change	Company Road Map
Description of the change	Please be informed that we are going to replace 3 mils gold (Au) wires on Power stage of VNQ5E250AJ-E, VNH5050ATR-E, VNH5180ATR-E with 2.5 mils Copper (Cu) wires. Wires on Input stage remain unchanged (Au).
Change Product Identification	Internal Traceability
Manufacturing Location(s)	

DOCUMENT APPROVAL

Name	Function
Liporace, Nicola	Marketing Manager
Nicoloso, Riccardo	Product Manager
Minerva, Francesco	Q.A. Manager



PROCESS/PRODUCT CHANGE NOTIFICATION

VNQ5E250AJ-E, VNH5050ATR-E, VNH5180ATR-E : Copper Wires Implementation

WHAT:

Replacement of 3 mils gold (Au) wires on Power stage of VNQ5E250AJ-E, VNH5050ATR-E,

VNH5180ATR-E with 2.5 mils Copper (Cu) wires.

Wires on Input stage remain unchanged (Au).

WHY:

Company road map.

WHO:

All the Customers that are using VNQ5E250AJ-E, VNH5050ATR-E, VNH5180ATR-E.

WHEN:

Change will be implemented according to the following scheduled dates:

- Qualification: enclosed to this PCN. (Reliability Reports RR004713CT2235 and RR004413CT2235)
- Samples availability: within Q1/2014
- Date of implementation: Within Q2/2014 upon Customer Agreement.

WHERE:

ST Bouskoura (Casablanca -Morocco) Assembly Plant.

ST Muar (Malaysia) Assembly Plant.

VNQ5E250AJ-E (VNR9) **Copper wire product version**

General Information	
Commercial Product	VNQ5E250AJ-E
Product Line	VNR9
Silicon process technology	VIPower M05E
Package	PowerSSO16

Revision history			
Rev.	Date of Release	Author	Changes description
0.1	November 29 th 2013	F. CEARULO - APG Q&R Catania	Creation

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3.3	6	Blocks diagram
3.4	6	Bonding diagram
4	7	Reliability qualification plan and results – Summary table

- 1. Reliability evaluations overview

1.1 Objectives

Aim of this report is to present the results of the reliability evaluations performed on **VNQ5E250AJ-E** (VNR9 as ST internal silicon line) in order to qualify the Copper 2.5mils wires usage on power stage.

This is a Quad Channel High-Side Driver with Analog Current Sense for Automotive Applications designed in VIPower M0_5 technology diffused in ST CT6 Catania (Italy) and assembled by ST Bouskoura (Morocco) in PowerSSO16 package.

The qualification was done according to **AEC_Q100 Rev.G** specification following the path described here below:

Test group as per AEC-Q100 Rev.G		Performed (Y/N)	Comment
A	Accelerated Environment Stress	N	Family approach
B	Accelerated Lifetime Simulation	N	N/A for this change
C	Package Assembly Integrity	Y	
D	Die Fabrication Reliability	N	N/A for this change
E	Electrical Verification	Y	
F	Defect Screening	N	To be implemented starting from first production lot
G	Cavity Package Integrity	N	N/A: not for plastic packaged devices

See details per each test group in section 4 of this report.

1.2 Results

All reliability tests have been completed with positive results neither functional nor parametric rejects were detected at final electrical testing.

Based on the overall positive results we consider the products qualified from a reliability point of view.

- 2. Traceability

Wafer fab information	
Wafer fab manufacturing location	STM CT6 CATANIA (Italy)
Wafer diameter (inches)	6
Silicon process technology	VIPOWER M0-5E
Die finishing back side	Ti-Ni-Au
Die size (micron)	4020 x 2040 micron
Metal levels / materials	AlSiCu / 2 levels (3.2 micron last level)
Die finishing front side	SiN / Polyimide
Diffusion Lots #	3323068

Assembly Information	
Assembly plant location	STM Bouskoura (Morocco)
Package description	PowerSSO16
Molding compound	RESIN SUMITOMO EME7026 D14.0mm W4.3g
Wires bonding materials/diameters	Cu 2.5mils (on power) / Au 1.3mils (on signal)
Die attach material	PREFORM Pb/Ag/Sn 95.5/2.5/2
Assembly Lots #	CZ33309601

Reliability Information	
Reliability test execution location	STM Catania (Italy)

- 3. Devices characteristics

3.1 Generalities



VNQ5E250AJ-E

Quad channel high-side driver with analog current sense
for automotive applications

Features

Max supply voltage	V_{CC}	41 V
Operating voltage range	V_{CC}	4 to 28 V
Max on-state resistance (per ch.)	R_{ON}	250 m Ω
Current limitation (typ)	I_{LIMH}	5 A
Off-state supply current	I_S	2 μ A ⁽¹⁾

1. Typical value with all loads connected.

- General
 - Inrush current active management by power limitation
 - Very low standby current
 - 3.0 V CMOS compatible inputs
 - Optimized electromagnetic emissions
 - Very low electromagnetic susceptibility
 - Compliant with European directive 2002/95/EC
 - Very low current sense leakage
- Diagnostic functions
 - Proportional load current sense
 - High current sense precision for wide currents range
 - Current sense disable
 - Off-state open-load detection
 - Output short to V_{CC} detection
 - Overload and short to ground (power limitation) indication
 - Thermal shutdown indication
- Protections
 - Undervoltage shutdown
 - Overvoltage clamp
 - Load current limitation
 - Self limiting of fast thermal transients
 - Protection against loss of ground and loss of V_{CC}



- Overtemperature shutdown with auto restart (thermal shutdown)
- Reverse battery protected
- Electrostatic discharge protection

Applications

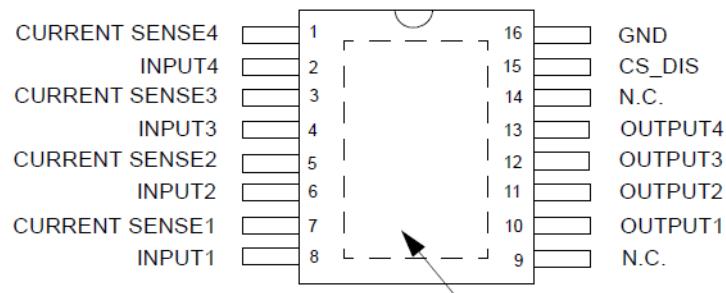
- All types of resistive, inductive and capacitive loads
- Suitable as LED driver
- Suitable as relays driver

Description

The VNQ5E250AJ-E is a quad channel high-side driver manufactured using ST proprietary VIPower™ M0-5 technology and housed in PowerSSO-16 package. The device is designed to drive 12 V automotive grounded loads, and to provide protection and diagnostics. It also implements a 3 V and 5 V CMOS compatible interface for the use with any microcontroller.

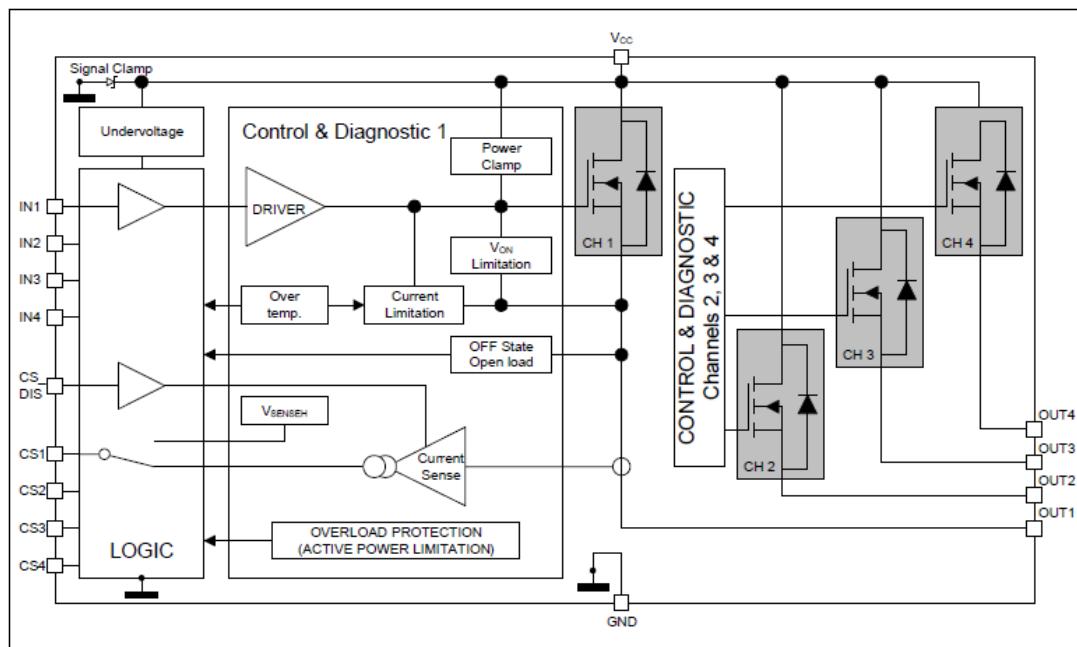
The device integrates advanced protective functions such as load current limitation, inrush and overload active management by power limitation, overtemperature shut-off with auto-restart and overvoltage active clamp. A dedicated analog current sense pin is associated with every output channel providing enhanced diagnostic functions including fast detection of overload and short-circuit to ground through power limitation indication, overtemperature indication, short-circuit to V_{CC} diagnosis and on-state and off-state open-load detection. The current sensing and diagnostic feedback of the whole device can be disabled by pulling the CS_DIS pin high to share the external sense resistor with similar devices.

3.2 Pins connection

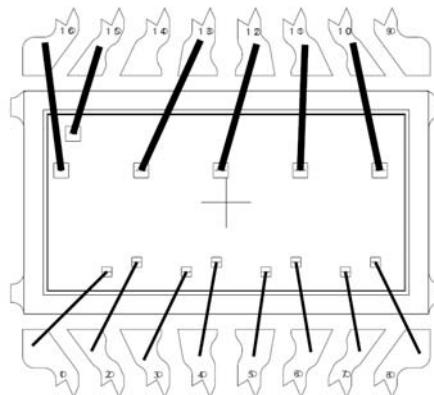


TAB=Vcc

3.3 Blocks diagram



3.4 Bonding diagram



- 4. Reliability qualification plan and results

Test group A: Accelerated Environment Stress					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
A1	PC Pre Cond	- Preconditioning according to Jedec JESD22-A113F including 5 Temperature Cycling Ta=-40°C/+60°C - Reflow according to level 3 Jedec JSTD020D-1 - 100 Temperature Cycling Ta=-50°C/+150°C			
A2	THB Temp Humidity Bias	Ta=85°C, RH=85%, Vcc=24V for 1000 hours			
A3	AC Autoclave	ENV. SEQ. Enviromental Sequence TC (Ta=-65°C / +150°C for 100 cycles) + AC (Ta=121°C, Pa=2atm for 96 hours)			Family approach with VND5E050AJ-E as test vehicle to qualify Copper 2.5mils usage on PSSO package (ST reference reports #RR000111CT6029_Rev.A)
A4	TC Temp. Cycling	Ta=-65°C / +150°C for 500 cycles			
A5	PTC Power Temp. Cycling	Ta=-40°C / +125°C for 1000 cycles.			
A6	HTSL High Temp. Storage Life	Ta=150°C for 1000 hours.			

Test group B: Accelerated Lifetime Simulation					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
B1	HTOL High Temp. Op. Life	Bias Dynamic stress (JESD22-A108): Ta=125°C for 1000 hours			Not Applicable for this change
B2	ELFR Early Life Failure Rate	Parts submitted to HTOL per JESD22-A108 requirements; GRADE 1: 24 hours at 150°C			
B3	EDR Endurance Data Retention	Not Applicable: Only for memory devices	-	-	

Test group C: Package Assembly Integrity					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
C1	WBS Wire Bond Shear		30 bonds /minimum 5 units/1 lot	All measurement within spec limits	
C2	WBP Wire Bond Pull		30 bonds /minimum 5 units/1 lot	All measurement within spec limits	
C3	SD Solderability		15/1	All measurement within spec limits	
C4	PD Physical Dimensions		30/1	All measurement within spec limits	
C5	SBS Solder Ball Shear	Not Applicable: only for BGA package	-	-	
C6	LI Lead Integrity	Not Applicable: not required for Surface Mount Devices	-	-	

Test group D: Die Fabrication Reliability					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
D1	EM Electromigration				
D2	TDDB Time Dependent Dielectric Breakdown				
D3	HCI Hot Carrier Injection				Not Applicable for this change
D4	NBTI Negative Bias Temperature Instability				
D5	SM Stress Migration				

Test group E: Electrical Verification					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
E2	ESD HBM / MM	HBM=[R=1.5kΩ, C=150pF]	15/1	MultiSense: ±2.0kV CS_DIS, INPUT: ±4.0kV OUTPUT, V _{cc} : ±5.0kV	
E3	ESD CDM		3/1	±750V	
E4	LU Latch-Up	Injection current : ±100mA Over voltage: 1.5 x V _{op} max	15/1	Inj-Low/Inj-High @125°C: ±50mA all pins Inj+Low/Inj+High @125°C: ±100mA all pins Overvoltage: passed	
E5	ED Electrical Distributions		3 lots	Completed	
E7	CHAR Characterization		3 lots	Completed	
E8	GL Gate Leakage		6/1	Not Applicable for this change	
E9	EMC Electromagnetic Compatibility		1/1	Not Applicable for this change	
E10	SC Short Circuit Characterization	According to AEC-Q100-012	-	-	

Test group F: Defects Screening Tests					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
F1	PAT Process Average Testing				Not performed on qualification lots listed on traceability section of this report.
F2	SBA Statistical Bin/Yield Analysis				To be implemented starting from first production lot

Test group G: Cavity Package Integrity Tests					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
G1	MS Mechanical Shock				
G2	VFV Variable Frequency Vibration				
G3	CA Constant Acceleration				
G4	GFL Gross/Fine Leak				
G5	DROP Package Drop				Not applicable: not for plastic packaged devices
G6	LT Lid Torque				
G7	DS Die Shear				
G8	IWV Internal Water Vapor				

VNH5050A-E (VH24) **Copper wire product version**

General Information	
Commercial Product	VNH5050A-E
Product Line	VH24
Silicon process technology	VIPower M05
Package	PowerSSO36TP

Revision history			
Rev.	Date of Release	Author	Changes description
0.1	November 29 th 2013	F. CEARULO - APG Q&R Catania	Creation

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- 1. Reliability evaluations overview

1.1 Objectives

Aim of this report is to present the results of the reliability evaluations performed on **VNH5050A-E** (VH24 as ST internal silicon line) in order to qualify the Copper 2.5mils wires usage on power stage.

This is a multichip Fully Integrated H-Bridge Motor Driver product for Automotive Applications designed in VIPower M0-5 technology composed by one High Side die (VNU3 as ST internal silicon code) diffused in ST AMK6 Ang Mo Kio (Singapore) and two Low Side dice (VNU4 as ST internal silicon code) diffused in ST CT6 Catania (Italy) and assembled by ST Muar (Malaysia) in PowerSSO36 TP package.

The qualification was done according to **AEC_Q100 Rev.G** specification following the path described here below:

Test group as per AEC-Q100 Rev.G		Performed (Y/N)	Comment
A	Accelerated Environment Stress	N	Family approach
B	Accelerated Lifetime Simulation	N	N/A for this change
C	Package Assembly Integrity	Y	
D	Die Fabrication Reliability	N	N/A for this change
E	Electrical Verification	Y	
F	Defect Screening	N	To be implemented starting from first production lot
G	Cavity Package Integrity	N	N/A: not for plastic packaged devices

See details per each test group in section 4 of this report.

1.2 Results

All reliability tests have been completed with positive result, neither functional nor parametric rejects were detected at final electrical testing.

Based on the overall positive results we consider the products qualified from a reliability point of view.

- 2. Traceability

Wafer fab information	
Wafer fab manufacturing location	High Side (VNU3): STM AMK6 Ang Mo Kio (Singapore) Low Side (VNU4): STM CT6 Catania (Italy)
Wafer diameter (inches)	6
Silicon process technology	VIPower M0-5
Die finishing back side	Ti-Ni-Au
Die size (micron)	(VNU3): 2850x4600 – (VNU4): 2850x1700
Metal levels / materials	(VNU3): 2 / AlSiCu (3.2 micron last level) (VNU4): 1 / AlSiCu (3.8 micron)
Die finishing front side	SiN / Polyimide
Diffusion Lots #	(VNU3) Lot 1: 3240604; (VNU4) Lot 1: 62411LL

Assembly Information	
Assembly plant location	ST Muar (Malaysia)
Package description	PowerSSO36TP
Molding compound	RESIN HITACHI CEL 9240HF10 D14mm W7.3g
Wires bonding materials/diameters	Cu 2.5mils (on power) / Au 1.2mils (on signal)
Die attach material	PREFORM Pb/Ag/Sn 97.5/1.5/1 D.76mm SSD
Assembly Lots #	Lot1: 9933507601

Reliability Information	
Reliability test execution location	STM Catania (Italy)

- 3. Devices characteristics

3.1 Generalities

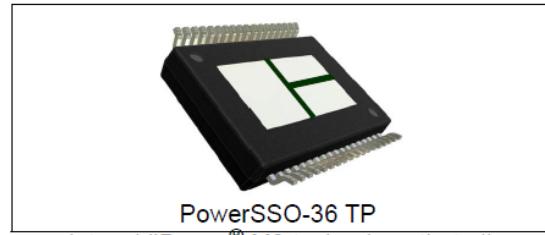

VNH5050A-E

Automotive fully integrated H-bridge motor driver

Features

Type	$R_{DS(on)}$	I_{out}	V_{ccmax}
VNH5050A-E	50 mΩ max (per leg)	30 A	41 V

- Output current: 30 A
- 3 V CMOS compatible inputs
- Undervoltage and overvoltage shutdown
- Overvoltage clamp
- Thermal shutdown
- Cross-conduction protection
- Current and power limitation
- Very low standby power consumption
- PWM operation up to 20 KHz
- Protection against loss of ground and loss of V_{CC}
- Current sense output proportional to motor current
- Output protected against short to ground and short to V_{CC}
- Package: ECOPACK®


PowerSSO-36 TP

proprietary VIPower® M0 technology that allows to efficiently integrate on the same die a true Power MOSFET with an intelligent signal/protection circuitry. The three dies are assembled in a PowerSSO-36 TP package on electrically isolated lead frames. This package, specifically designed for the harsh automotive environment offers improved thermal performance thanks to exposed die pads. Moreover, its fully symmetrical mechanical design allows superior manufacturability at board level. The input signals IN_A and IN_B can directly interface to the microcontroller to select the motor direction and the brake condition. The $DIAG_A/EN_A$ or $DIAG_B/EN_B$, when connected to an external pull-up resistor, enables one leg of the bridge. Each $DIAG_A/EN_A$ provides a digital diagnostic feedback signal as well. The normal operating condition is explained in the truth table. The CS pin allows monitoring the motor current by delivering a current proportional to its value when CS_DIS pin is driven low or left open. When CS_DIS is driven high, CS pin is in high impedance condition. The PWM, up to 20 KHz, allows to control the speed of the motor in all possible conditions. In all cases, a low level state on the PWM pin turns off both the LS_A and LS_B switches.

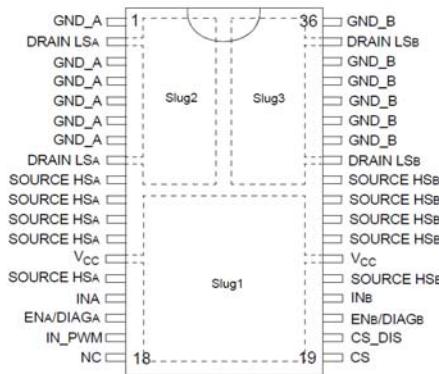
Description

The VNH5050A-E is a full bridge motor driver intended for a wide range of automotive applications. The device incorporates a dual monolithic high-side driver and two low-side switches. All switches are designed using STMicroelectronics® well known and proven

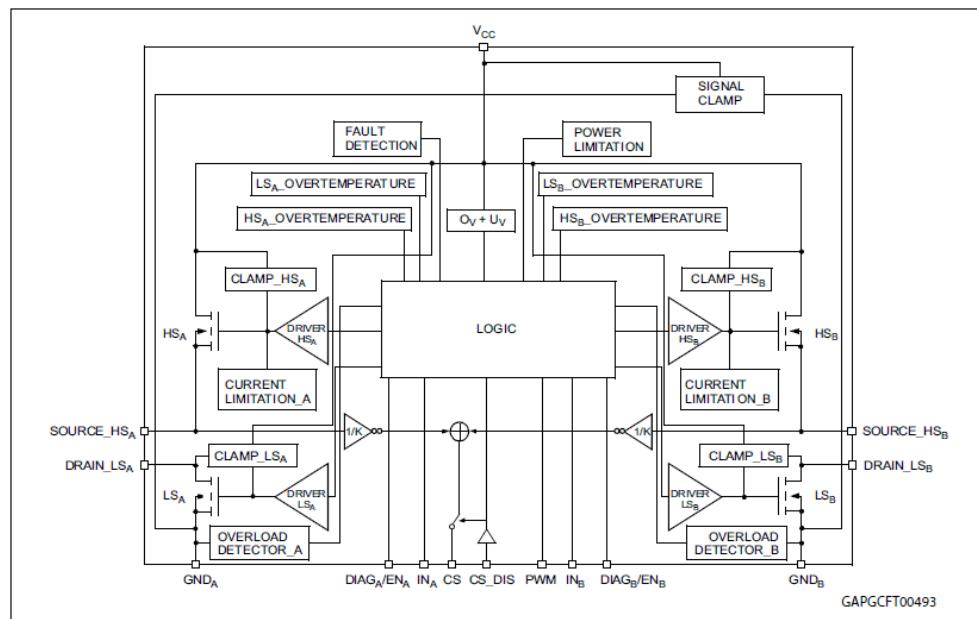
Table 1. Device summary

Package	Order codes	
	Tube	Tape and reel
PowerSSO-36 TP	VNH5050A-E	VNH5050ATR-E

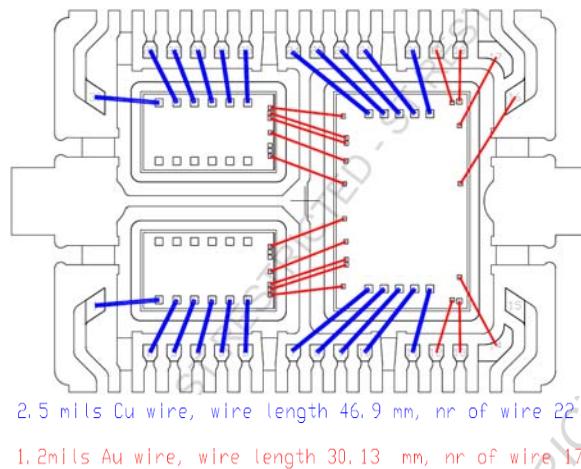
3.2 Pins connection



3.3 Blocks diagram



3.4 Bonding diagram



- 4. Reliability qualification plan and results

Test group A: Accelerated Environment Stress					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
A1	PC Pre Cond	<ul style="list-style-type: none"> - Preconditioning according to Jedec JESD22-A113F including 5 Temperature Cycling $T_a=-40^{\circ}\text{C}/+60^{\circ}\text{C}$ - Reflow according to level 3 Jedec JSTD020D-1 - 100 Temperature Cycling $T_a=-50^{\circ}\text{C}/+150^{\circ}\text{C}$ 			
A2	THB Temp Humidity Bias	$T_a=85^{\circ}\text{C}$, RH=85%, Vcc=24V for 1000 hours			
A3	AC Autoclave	ENV. SEQ. Environmental Sequence TC ($T_a=-65^{\circ}\text{C} / +150^{\circ}\text{C}$ for 100 cycles) + AC ($T_a=121^{\circ}\text{C}$, $P_a=2\text{atm}$ for 96 hours)			Family approach with: 1st bond <ul style="list-style-type: none"> - VND5012AK-E same technology, copper qualification in package PSSO24 single island (ST reference reports # RR004110CT6025) - VND5E012AY-E same technology, copper qualification in package PSSO36 double island (ST reference reports # RR002910CT6025) 2nd bond <ul style="list-style-type: none"> - VNH7013XP-E different technology, copper qualification in package PSSO36 triple island (ST reference reports # RR003111CT6025)
A4	TC Temp. Cycling	$T_a=-65^{\circ}\text{C} / +150^{\circ}\text{C}$ for 500 cycles			
A5	PTC Power Temp. Cycling	$T_a=-40^{\circ}\text{C} / +125^{\circ}\text{C}$ for 1000 cycles.			
A6	HTSL High Temp. Storage Life	$T_a=150^{\circ}\text{C}$ for 1000 hours.			

Test group B: Accelerated Lifetime Simulation					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
B1	HTOL High Temp. Op. Life	Bias Dynamic stress (JESD22-A108): $T_a=125^{\circ}\text{C}$ for 1000 hours			
B2	ELFR Early Life Failure Rate	Parts submitted to HTOL per JESD22-A108 requirements; GRADE 1: 24 hours at 150°C			Not Applicable for this change
B3	EDR Endurance Data Retention	Not Applicable: Only for memory devices	-	-	

Test group C: Package Assembly Integrity					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
C1	WBS Wire Bond Shear		30 bonds /minimum 5 units/1 lot	All measurement within spec limits	
C2	WBP Wire Bond Pull		30 bonds /minimum 5 units/1 lot	All measurement within spec limits	
C3	SD Solderability		15/1	All measurement within spec limits	
C4	PD Physical Dimensions		30/1	All measurement within spec limits	
C5	SBS Solder Ball Shear	Not Applicable: only for BGA package	-	-	
C6	LI Lead Integrity	Not Applicable: not required for Surface Mount Devices	-	-	

Test group D: Die Fabrication Reliability					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
D1	EM Electromigration				
D2	TDDB Time Dependent Dielectric Breakdown				
D3	HCI Hot Carrier Injection				Not Applicable for this change
D4	NBTI Negative Bias Temperature Instability				
D5	SM Stress Migration				

Test group E: Electrical Verification					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
E2	ESD HBM / MM	HBM=[R=1.5kΩ, C=150pF]	6/1	±2.0kV	
E3	ESD CDM		3/1	±500V	
E4	LU Latch-Up	Injection current : ±100mA Over voltage: 1.5 x V _{op} max	14/1	Inj-Low/Inj-High @125°C: ±50mA all pins Inj-Low/Inj+High @125°C: ±100mA all pins Overvoltage: passed	
E5	ED Electrical Distributions		3 lots	Completed	
E7	CHAR Characterization		3 lots	Completed	
E8	GL Gate Leakage		6/1	Not Applicable for this change	
E9	EMC Electromagnetic Compatibility		1/1	Not Applicable for this change	
E10	SC Short Circuit Characterization	According to AEC-Q100-012	-	-	

Test group F: Defects Screening Tests					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
F1	PAT Process Average Testing				Not performed on qualification lots listed on traceability section of this report. To be implemented starting from first production lot
F2	SBA Statistical Bin/Yield Analysis				

Test group G: Cavity Package Integrity Tests					
AEC #	Test Name	STM Test Conditions	Sample Size/ Lots	Results Fails/SS/Lots	Comments
G1	MS Mechanical Shock				
G2	VFV Variable Frequency Vibration				
G3	CA Constant Acceleration				
G4	GFL Gross/Fine Leak				
G5	DROP Package Drop				Not applicable: not for plastic packaged devices
G6	LT Lid Torque				
G7	DS Die Shear				
G8	IWV Internal Water Vapor				



Public Products List

PCN Title : VNQ5E250AJ-E, VNH5050ATR-E, VNH5180ATR-E:Copper Wire Implementation

PCN Reference : APG-ABD/13/8272

PCN Created on : 20-DEC-2013

Subject : Public Products List

Dear Customer,

Please find below the Standard Public Products List impacted by the change:

ST COMMERCIAL PRODUCT

VNH5050A-E

VNH5180ATR-E

VNH5050ATR-E

VNQ5E250AJ-E

VNH5180A-E

VNQ5E250AJTR-E

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