NBM™ in a VIA Package Bus Converter

NBM3814x46C15A6yzz

Non-Isolated, Fixed-Ratio DC-DC Converter

Features & Benefits

- Up to 160A continuous low voltage side current
- Fixed transformation ratio(K) of 1/3
- Up to 1258 W/in^3 power density
- 97.9% peak ef ciency
- Bidirectional operation capability
- Integrated ceramic capacitance ltering
- Parallel operation for multi-kW arrays
- OV, OC, UV, short circuit and thermal protection
- 3814 package
- High MTBF
- Thermally enhanced VIA package

Typical Applications

- DC Power Distribution
- Information and Communication Technology (ICT) Equipment
- High End Computing Systems
- Automated Test Equipment
- Industrial Systems
- High Density Energy Systems
- Transportation

Size:
3.76 x 1.40 x 0.37 in
95.59 x 35.54 x 9.40 mm

Product Ratings	
V_{HI} = 42V (36 – 46V)	I_{LO} = up to 160A
V_{LO} = 14V (12 – 15.3V) (NO LOAD)	K = 1/3

Product Description

The NBM in a VIA package is a high efficiency Bus Converter, operating from a 36 to 46V_{DC} high voltage bus to deliver a non-isolated 12 to 15.3V_{DC} unregulated, low voltage.

This unique ultra-low profile module incorporates DC-DC conversion, integrated filtering in a chassis or PCB mount form factor.

The NBM offers low noise, fast transient response and industry leading efficiency and power density.

Leveraging the thermal and density benefits of Vicor's VIA packaging technology, the NBM module offers flexible thermal management options with very low top and bottom side thermal impedances.

When combined with downstream Vicor DC-DC conversion components and regulators, the NBM allows the Power Design Engineer to employ a simple, low-profile design which will differentiate the end system without compromising on cost or performance metrics.

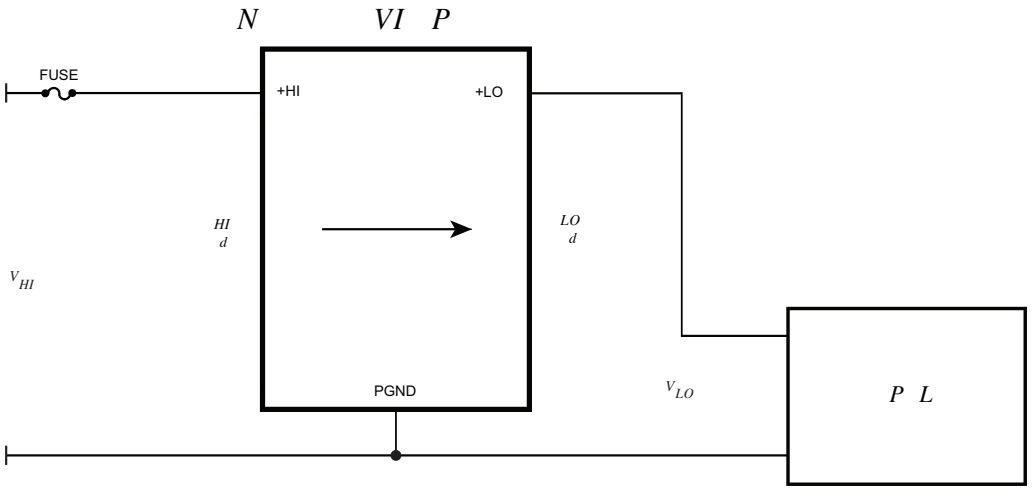
The NBM non-isolated topology allows start up and steady state operation in forward and reverse directions. It provides bidirectional protections. However if power train is disabled by any protection, and V_{LO} is present, then voltage equal to V_{LO} minus two diode drops will appear on high voltage side.

Part Ordering Information

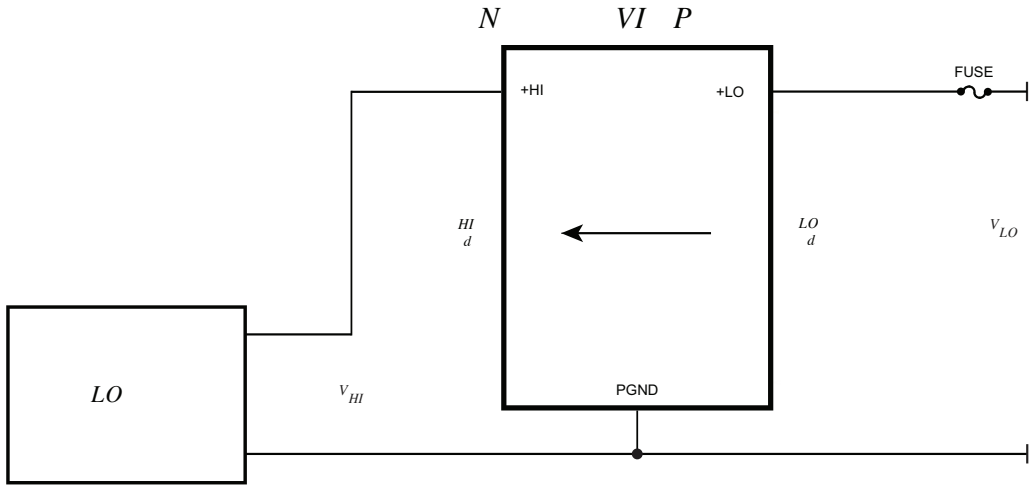
Product Function	Package Length	Package Width	Package Type	Max High Side Voltage	High Side Voltage Range Ratio	Max Low Side Voltage	Max Low Side Current	Product Grade (Case Temperature)	Option Field
NBM	38	14	x	46	C	15	A6	y	zz
NBM = Non-Isolated Bus Converter Module	Length in Inches x 10	Width in Inches x 10	B = Board VIA V = Chassis VIA	Internal Reference				C = -20 to 100°C[1] T = -40 to 100°C[1]	00 = Chassis/Always On 04 = Short Pin/Always On 08 = Long Pin/Always On

[1] High Temperature Current Derating may apply; See Figure 1, specified thermal operating area.

Typical Application

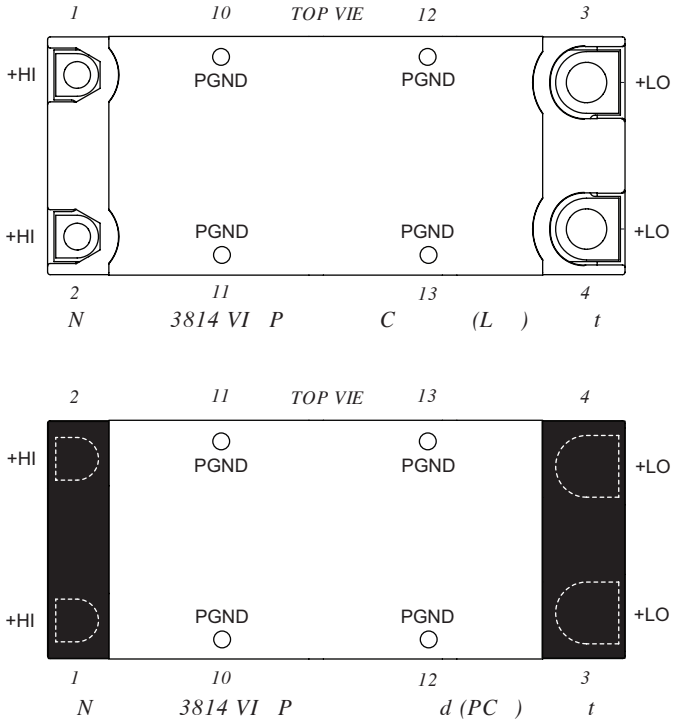


NBM3814x46C15A6yzz at point of load providing xed ratio step-down DC-DC conversion to PoL devices. NBM is operating in forward direction.



NBM3814x46C15A6yzz providing xed ratio step-up DC-DC conversion. NBM is operating in reverse direction.

Pin Configuration



Pin Descriptions

Pin Number	Signal Name	Type	Function
1, 2	+HI	HIGH SIDE POWER	Positive auto-transformer power terminal - on high voltage side
3, 4	+LO	LOW SIDE POWER	Positive auto-transformer power terminal - on low voltage side
10, 11, 12, 13	PGND	POWER RETURN	Common negative auto-transformer power terminal

Absolute Maximum Ratings

The absolute maximum ratings below are stress ratings only. Operation at or beyond these maximum ratings can cause permanent damage to the device.

Parameter	Comments	Min	Max	Unit
+HI to PGND		-1	60	V
HI_DC or LO_DC slew rate			1	V/µs
+LO to PGND		-1	20	V
Dielectric Withstand*	See note below			
High Voltage Side to Case		N/A		V_{DC}
High Voltage Side to Low Voltage Side		N/A		V_{DC}
Low Voltage Side to Case		N/A		V_{DC}

* The PGND of the NBM in a VIA package is directly connected to the case. The NBM does not contain any insulation (isolation) from high voltage side to low voltage side

Electrical Specifications

Specifications apply over all line and load conditions, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C ≤ T_{CASE} ≤100°C (T-Grade); All other specifications are at T_{CASE} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
General Powertrain High Voltage Side to Low Voltage Side Specification (Forward Direction)						
Hi Side Input Voltage range, continuous	V_{HI_DC}		**36**		**46**	V
V_{HI} µController	$V_{\mu C\_ACTIVE}$	V_{HI_DC} voltage where µC is initialized, (powertrain inactive)			15	V
HI to LO Input Quiescent Current	I_{HI_Q}	Disabled, V_{HI_DC} = 42V		8		mA
		T_{CASE} ≤ 100°C			12	
HI to LO No Load Power Dissipation	P_{HI_NL}	V_{HI_DC} = 42V, T_{CASE} = 25°C		12.5	19.5	W
		V_{HI_DC} = 42V	**5**		**28**	
		V_{HI_DC} = 36V to 46V, T_{CASE} = 25 °C			22	
		V_{HI_DC} = 36V to 46V			**31**	
HI to LO Inrush Current Peak	$I_{HI\_INR\_PK}$	V_{HI_DC} = 46V, C_{LO_EXT} = 3000µF, R_{LOAD_LO} = 20% of full load current		30		A
		T_{CASE} ≤ 100°C			75	
DC HI Side Input Current	$I_{HI\_IN\_DC}$	At $I_{LO\_OUT\_DC}$ = 160A, T_{CASE} ≤ 85°C			53.9	A
Transformation Ratio	K	High voltage to low voltage, K = V_{LO_DC} / V_{HI_DC}, at no load		1/3		V/V
LO Side Output Current (continuous)	$I_{LO\_OUT\_DC}$	T_{CASE} ≤ 85°C			160	A
LO Side Output Current (pulsed)	$I_{LO\_OUT\_PULSE}$	10ms pulse, 25% Duty cycle, $I_{LO\_OUT\_AVG}$ ≤ 50% rated $I_{LO\_OUT\_DC}$			176	A
HI to LO Efficiency (ambient)	η_{AMB}	V_{HI_DC} = 42V, $I_{LO\_OUT\_DC}$ = 160A	96.8	97.6		%
		V_{HI_DC} = 36V to 46V, $I_{LO\_OUT\_DC}$ = 160A	96.5			
		V_{HI_DC} = 42V, $I_{LO\_OUT\_DC}$ = 80A	97.3	97.8		
HI to LO Efficiency (hot)	η_{HOT}	V_{HI_DC} = 42V, $I_{LO\_OUT\_DC}$ = 160A, T_{CASE} = 85°C	96.7	97.1		%
HI to LO Efficiency (over load range)	$\eta_{20\%}$	32A < $I_{LO\_OUT\_DC}$ < 160A	95			%
HI to LO Output Resistance	R_{LO_COLD}	V_{HI_DC} = 42V, $I_{LO\_OUT\_DC}$ = 160A, T_{CASE} = -40°C	0.8	1.3	1.7	mΩ
	R_{LO_AMB}	V_{HI_DC} = 42V, $I_{LO\_OUT\_DC}$ = 160A	0.9	1.7	2.1	
	R_{LO_HOT}	V_{HI_DC} = 42V, $I_{LO\_OUT\_DC}$ = 160A, T_{CASE} = 85°C	1.5	2.1	2.4	
Switching Frequency	F_{SW}	Frequency of the LO Side Voltage Ripple = 2x F_{SW}	**1.14**	1.20	**1.26**	MHz
LO Side Output Voltage Ripple	$V_{LO\_OUT\_PP}$	C_{LO_EXT} = 0µF, $I_{LO\_OUT\_DC}$ = 160A, V_{HI_DC} = 42V, 20MHz BW		110		mV
		T_{CASE} ≤ 100°C			205	

Electrical Specifications (Cont.)

Specifications apply over all line and load conditions, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C ≤ T_{CASE} ≤100°C (T-Grade); All other specifications are at T_{CASE} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
General Powertrain High Voltage Side to Low Voltage Side Specification (Forward Direction) Cont.						
Effective HI side Capacitance (Internal)	C_{HI_INT}	Effective Value at 42V_{HI_DC}		16.8		µF
Effective LO Side Capacitance (Internal)	C_{LO_INT}	Effective Value at 14V_{LO_DC}		140		µF
Effective LO Side Output Capacitance (External)	$C_{LO\_OUT\_EXT}$	Excessive capacitance may drive module into SC protection			**3000**	µF
Effective LO Side Output Capacitance (External)	$C_{LO\_OUT\_AEXT}$	$C_{LO\_OUT\_AEXT}$ Max = N * 0.5 * $C_{LO\_OUT\_EXT\ MAX}$, where N = the number of units in parallel				
Protection High Voltage Side to Low Voltage Side (Forward Direction)						
Auto Restart Time	$t_{AUTO\_RESTART}$	Startup into a persistent fault condition. Non-Latching fault detection given V_{HI_DC} > V_{HI_UVLO+}	**940**		**1010**	ms
HI Side Overvoltage Lockout Threshold	V_{HI_OVLO+}		**48**	50	**52**	V
HI Side Overvoltage Recovery Threshold	V_{HI_OVLO-}		**46**	48	**50**	V
HI Side Overvoltage Lockout Hysteresis	$V_{HI\_OVLO\_HYST}$			2		V
HI Side Overvoltage Lockout Response Time	t_{HI_OVLO}			30		µs
HI Side Undervoltage Lockout Threshold	V_{HI_UVLO-}		**28**	30	**32**	V
HI Side Undervoltage Recovery Threshold	V_{HI_UVLO+}		**30**	32	**34**	V
HI Side Undervoltage Lockout Hysteresis	$V_{HI\_UVLO\_HYST}$			2		V
HI Side Undervoltage Lockout Response Time	t_{HI_UVLO}			100		µs
HI Side Undervoltage Startup Delay	$t_{HI\_UVLO+\_DELAY}$	From V_{HI_DC} = V_{HI_UVLO+} to powertrain active, (i.e One time Startup delay form application of V_{HI_DC} to V_{LO_DC})		30		ms
HI Side Soft-Start Time	$t_{HI\_SOFT-START}$	From powertrain active. Fast Current limit protection disabled during Soft-Start		1		ms
LO Side Output Overcurrent Trip Threshold	$I_{LO\_OUT\_OCP}$		**177**	200	**240**	A
LO Side Output Overcurrent Response Time Constant	$t_{LO\_OUT\_OCP}$	Effective internal RC filter		4		ms
LO Side Output Short Circuit Protection Trip Threshold	$I_{LO\_OUT\_SCP}$		**240**			A
LO Side Output Short Circuit Protection Response Time	$t_{LO\_OUT\_SCP}$			1		µs
Overtemperature Shutdown Threshold	t_{OTP+}	Temperature sensor located inside controller IC	**125**			°C
Overtemperature Recovery Threshold	t_{OTP-}		105	110	115	°C
Undertemperature Shutdown Threshold	t_{UTP}	Temperature sensor located inside controller IC; Protection not available for M-Grade units.			-45	°C
Undertemperature Restart Time	$t_{UTP\_RESTART}$	Startup into a persistent fault condition. Non-Latching fault detection given V_{HI_DC} > V_{HI_UVLO+}		3		s

Electrical Specifications (Cont.)

Specifications apply over all line and load conditions, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C ≤ T_{CASE} ≤100°C (T-Grade); All other specifications are at T_{CASE} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
General Powertrain Low Voltage Side to High Voltage Side Specification (Reverse Direction)						
LO Side Input Voltage range, continuous	V_{LO_DC}		**12**		**15.3**	V
LO to HI No Load Power Dissipation	P_{LO_NL}	V_{LO_DC} = 14V, T_{CASE} = 25°C		12.5	20	W
		V_{LO_DC} = 14V	**5**		**29**	
		V_{LO_DC} = 12V to 15.3V, T_{CASE} = 25°C			22	
		V_{LO_DC} = 12V to 15.3V			**31**	
DC LO Side Input Current	$I_{LO\_IN\_DC}$	At I_{HI_DC} = 53.3A, T_{CASE} ≤ 85°C			**162**	A
HI Side Output Current (continuous)	$I_{HI\_OUT\_DC}$	T_{CASE} ≤ 85°C			**53.3**	A
HI Side Output Current (pulsed)	$I_{HI\_OUT\_PULSE}$	10ms pulse, 25% Duty cycle, $I_{HI\_OUT\_AVG}$ ≤ 50% rated $I_{HI\_OUT\_DC}$			**58.7**	A
LO to HI Efficiency (ambient)	η_{AMB}	V_{LO_DC} = 14V, $I_{HI\_OUT\_DC}$ = 53.3A	96.4	97.2		%
		V_{LO_DC} = 12V to 15.3V, $I_{HI\_OUT\_DC}$= 53.3A	96.1			
		V_{LO_DC} = 14V, $I_{HI\_OUT\_DC}$ = 26.7A	97.3	97.8		
LO to HI Efficiency (hot)	η_{HOT}	V_{LO_DC} = 14V, $I_{HI\_OUT\_DC}$ = 53.3A, T_{CASE} = 85°C	96.3	96.9		%
LO to HI Efficiency (over load range)	$\eta_{20\%}$	10.66A < $I_{HI\_OUT\_DC}$ < 53.3A	**94.6**			%
LO to HI Output Resistance	R_{HI_COLD}	V_{LO_DC} = 14V, $I_{HI\_OUT\_DC}$ = 53.3A, T_{CASE} = -40°C	10	16	20	mΩ
	R_{HI_AMB}	V_{LO_DC} = 14V, $I_{HI\_OUT\_DC}$ = 53.3A	12	20	24	
	R_{HI_HOT}	V_{LO_DC} = 14V, $I_{HI\_OUT\_DC}$ = 53.3A, T_{CASE} = 85°C	16	23	26	
HI Side Output Voltage Ripple	$V_{HI\_OUT\_PP}$	$C_{HI\_OUT\_EXT}$ = 0µF, $I_{HI\_OUT\_DC}$ = 53.3A, V_{LO_DC} = 14V, 20MHz BW		330		mV
		T_{CASE} ≤ 100°C			**615**	

Electrical Specifications (Cont.)

Specifications apply over all line and load conditions, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C ≤ T_{CASE} ≤100°C (T-Grade); All other specifications are at T_{CASE} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Protection Low Voltage Side to High Voltage Side (Reverse Direction)						
Effective HI Side Output Capacitance (External)	$C_{HI\_OUT\_EXT}$	Excessive capacitance may drive module into SC protection when starting from low voltage side to high voltage side			**300**	µF
LO Side Overvoltage Lockout Threshold	V_{LO_OVLO+}		**16**	16.7	**17.4**	V
LO Side Overvoltage Recovery Threshold	V_{HI_OVLO-}		**15.3**	16	**16.7**	V
LO Side Overvoltage Lockout Response Time	t_{HI_OVLO}			30		µs
LO Side Undervoltage Lockout Threshold	V_{LO_UVLO-}		**9.3**	10	**10.7**	V
LO Side Undervoltage Recovery Threshold	V_{HI_UVLO+-}		**10**	10.7	**11.4**	V
LO Side Undervoltage Lockout Response Time	t_{LO_UVLO}			100		µs
HI Side Output Overcurrent Trip Threshold	$I_{HI\_OUT\_OCP}$	Powertrain is stopped but current can flow from LO Side to HI Side through MOSFET body Diodes	**56**	66.7	**80**	A
HI Side Output Overcurrent Response Time Constant	$t_{HI\_OUT\_OCP}$	Effective internal RC filter		4		ms
HI Side Short Circuit Protection Trip Threshold	I_{HI_SCP}	Powertrain is stopped but current can flow from LO Side to HI Side through MOSFET body Diodes	**810**			A
HI Side Short Circuit Protection Response Time	t_{HI_SCP}			1		µs

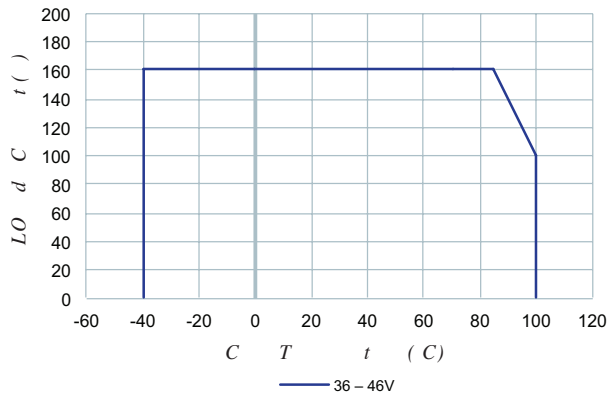


Figure 1 — *Specified thermal operating area*

1. The NBM in a VIA Package is cooled through bottom case (bottom housing).
2. The thermal rating of the NBM in a VIA Package is based on typical measured device efficiency.
3. The case temperature in the graph is the measured temperature of the bottom housing, such that operating internal junction temperature of the NBM in a VIA Package does not exceed 125°C.

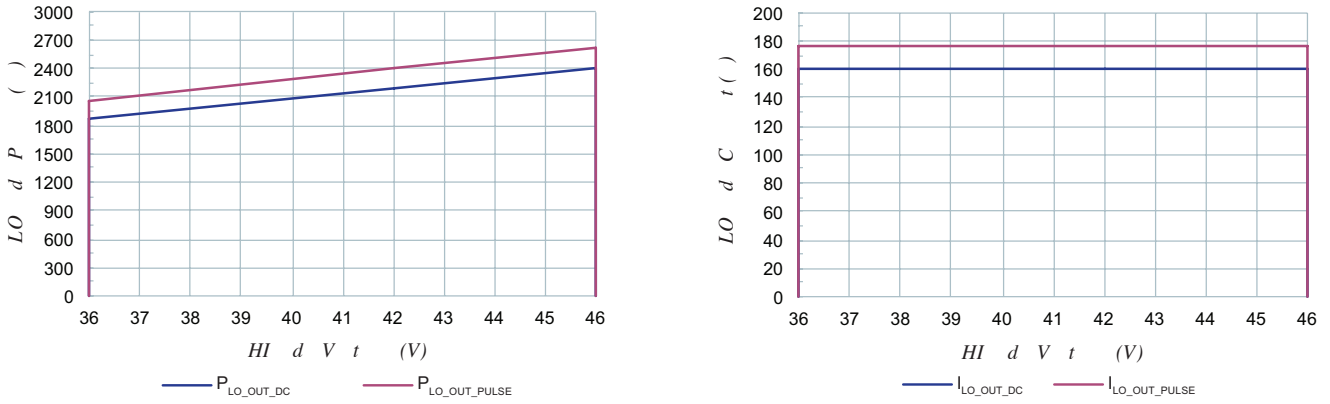


Figure 2 — *Specified electrical operating area using rated R_{LO_HOT}*

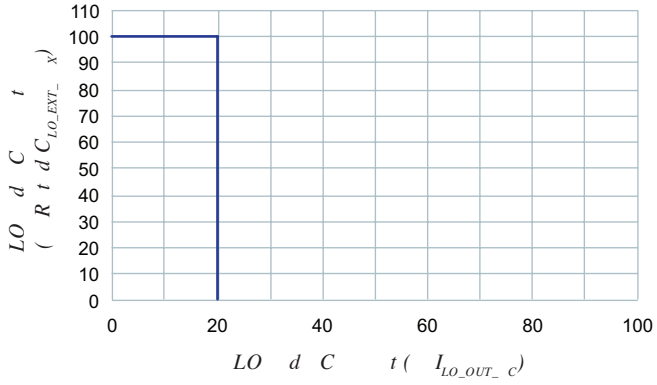
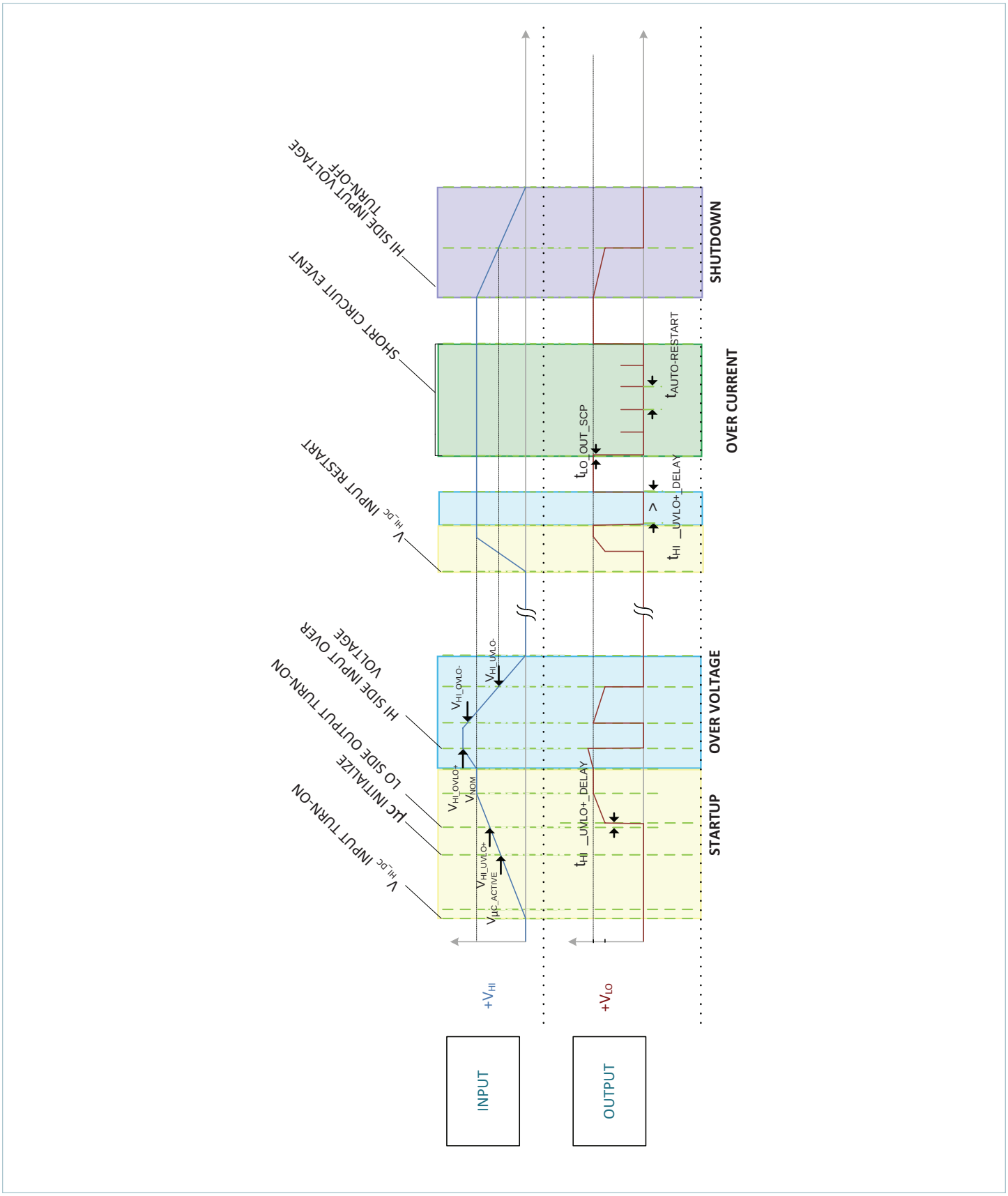
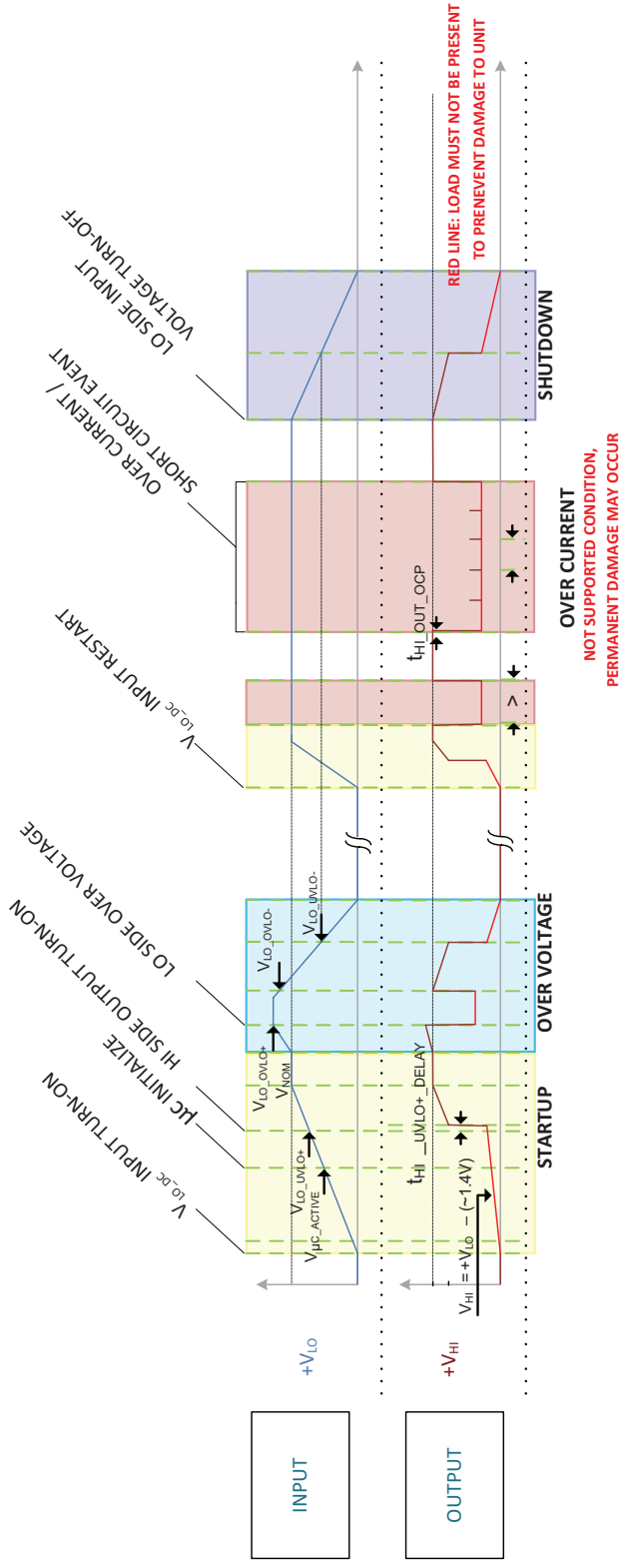


Figure 3 — *Specified HI side start-up into load current and external capacitance*

NBM™ Forward Direction Timing Diagram



NBM™ Reverse Direction Timing Diagram



Application Characteristics

Product is mounted and temperature controlled via top side cold plate, unless otherwise noted. All data presented in this section are collected data from high voltage side sourced units processing power in forward direction.See associated figures for general trend data.

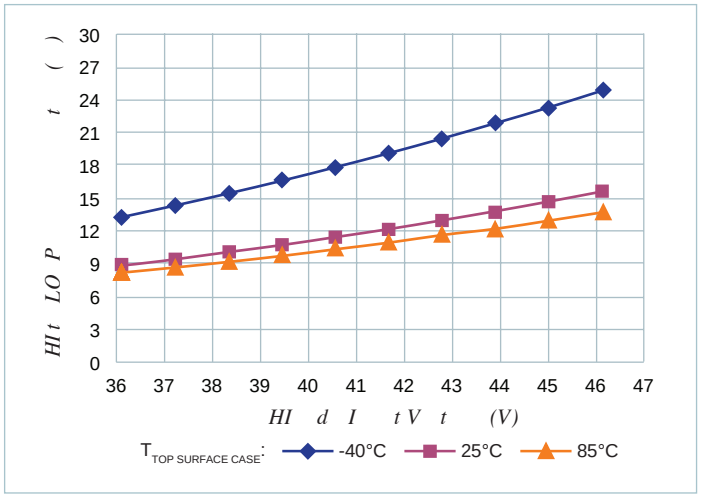


Figure 4 — *No load power dissipation vs. V_{HI_DC}*

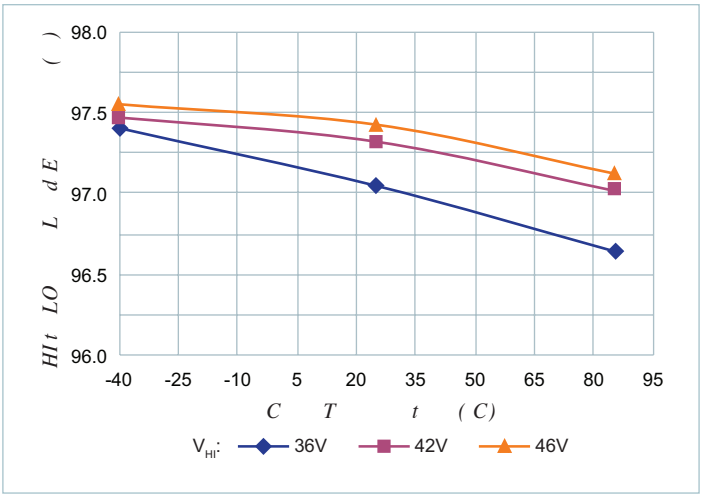


Figure 5 — *Full load efficiency vs. temperature; V_{HI_DC}*

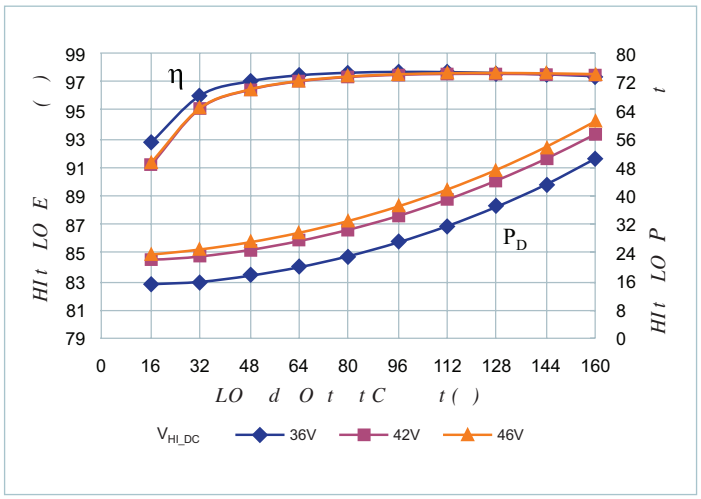


Figure 6 — *Efficiency and power dissipation at T_{CASE} = -40°C*

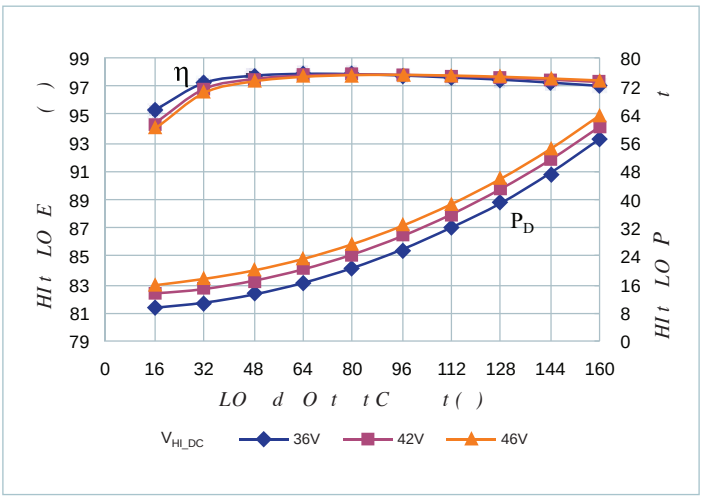


Figure 7 — *Efficiency and power dissipation at T_{CASE} = 25°C*

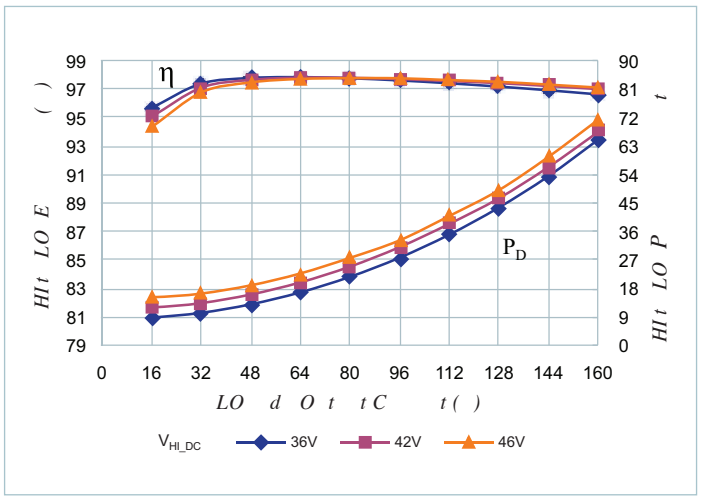


Figure 8 — *Efficiency and power dissipation at T_{CASE} = 85°C*

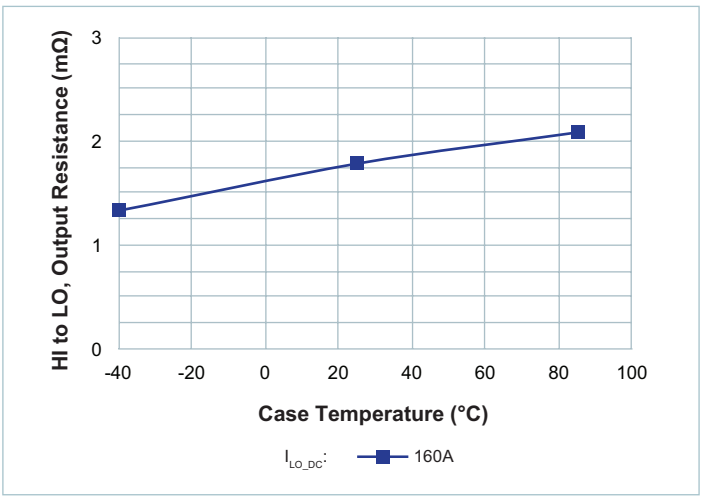


Figure 9 — *R_{LO} vs. temperature; Nominal V_{HI_DC}*
I_{LO_DC} = 160A at T_{CASE} = 85°C

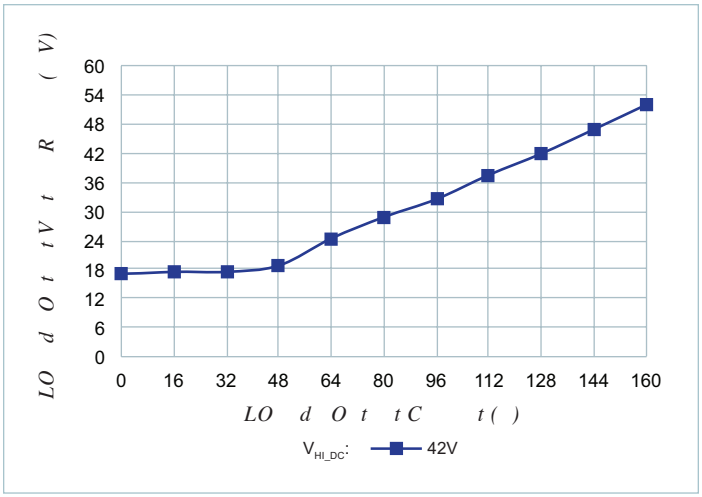


Figure 10 — *$V_{LO\_OUT\_PP}$ vs. I_{LO_DC} ; No external $C_{LO\_OUT\_EXT}$. Board mounted module, scope setting : 20MHz analog BW*

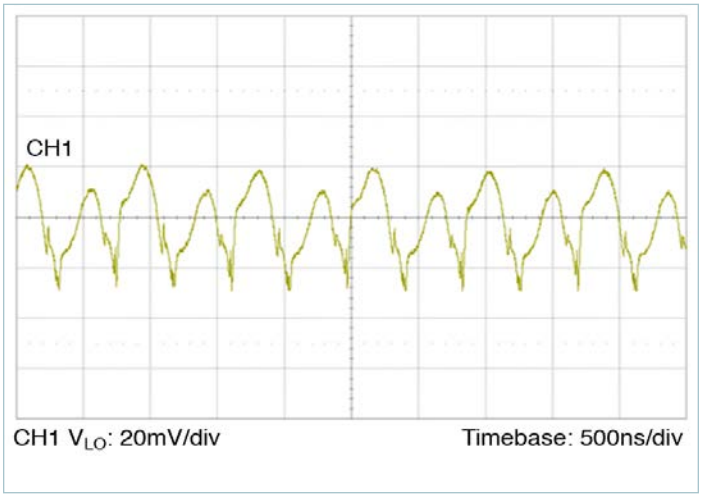


Figure 11 — *Full load ripple, 300µF $C_{HI\_IN\_EXT}$; No external $C_{LO\_OUT\_EXT}$. Board mounted module, scope setting : 20MHz analog BW*

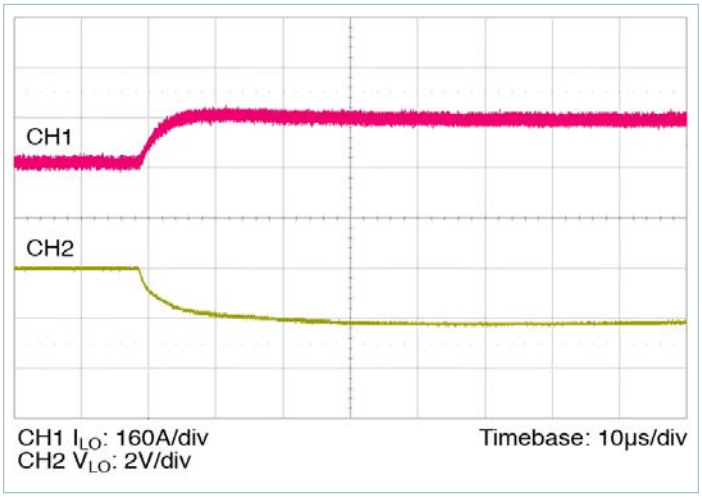


Figure 12 — *0A– 160A transient response: $C_{HI\_IN\_EXT}$ = 300µF, no external $C_{LO\_OUT\_EXT}$*

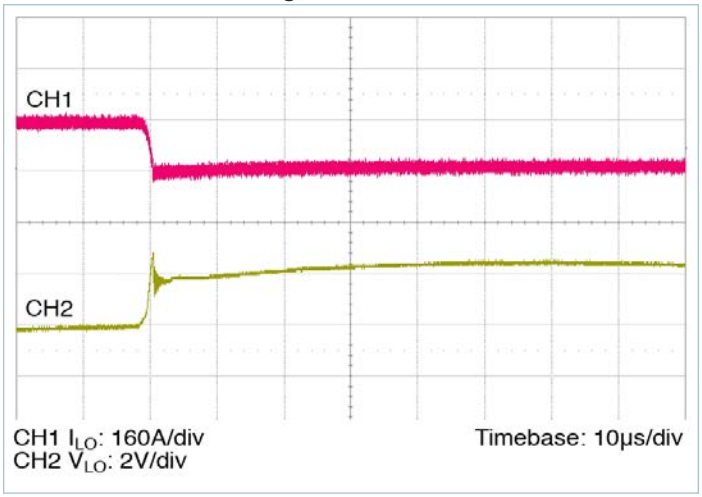


Figure 13 — *160A – 0A transient response: $C_{HI\_IN\_EXT}$ = 300µF, no external $C_{LO\_OUT\_EXT}$*

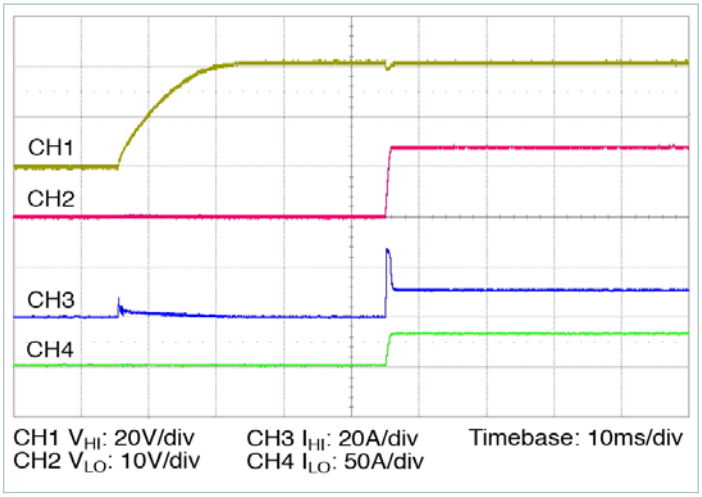


Figure 14 — *Forward start up from application of V_{HI_DC} = 42V, 20% I_{LO_DC}, 100% $C_{LO\_OUT\_EXT}$*

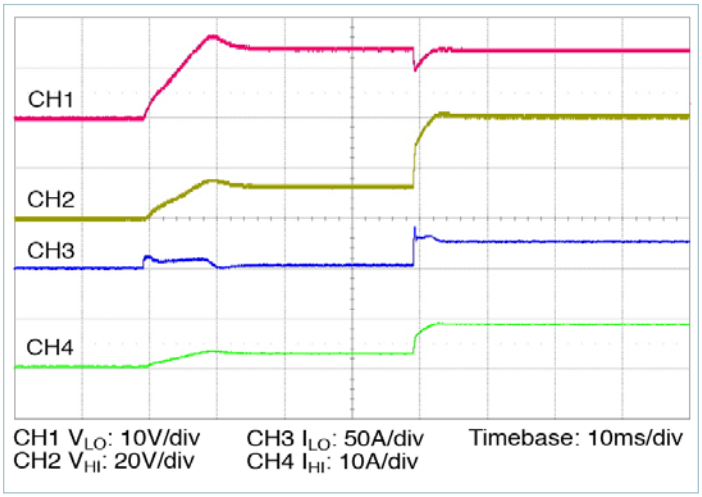


Figure 15 — *Reverse start up from application of V_{LO_DC} = 14V, 20% I_{HI_DC}, 100% $C_{HI\_OUT\_EXT}$*

General Characteristics

Specifications apply over all line, load conditions, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C ≤ T_{CASE} ≤100°C (T-Grade); All other specifications are at T_{CASE} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Mechanical						
Length	L	Lug (Chassis) Mount	95.34 / [3.75]	95.59 / [3.76]	95.84 / [3.77]	mm / [in]
Length	L	PCB (Board) Mount	95.34 / [3.75]	95.59 / [3.76]	95.84 / [3.77]	mm / [in]
Width	W		35.29 / [1.39]	35.54 / [1.40]	35.79 / [1.41]	mm / [in]
Height	H		9.019 / [0.355]	9.40 / [0.37]	9.781 / [0.385]	mm / [in]
Volume	Vol	Without heatsink		31.93 / [1.95]		cm^3/ [in^3]
Weight	W			130.4 / [4.6]		g / [oz]
Pin Material		C145 copper, 1/2 hard				
Underplate		Low stress ductile Nickel	50		100	µin
Pin Finish		Palladium	0.8		6	µin
		Soft Gold	0.12		2	
Thermal						
Operating junction temperature	$T_{INTERNAL}$	NBM3814x46C15A6yzz (T-Grade)	-40		125	°C
		NBM3814x46C15A6yzz (C-Grade)	-20		125	
Operating case temperature	T_{CASE}	NBM3814x46C15A6yzz (T-Grade), derating applied, see safe thermal operating area	-40		100	
		NBM3814x46C15A6yzz (C-Grade), derating applied, see safe thermal operating area	-20		100	
Thermal resistance top side	R_{JC_TOP}	Estimated thermal resistance to maximum temperature internal component from isothermal top		1.39		°C/W
Thermal Resistance Coupling between top case and bottom case	R_{HOU}	Estimated thermal resistance of thermal coupling between the top and bottom case surfaces		0.51		°C/W
Thermal resistance bottom side	R_{JC_BOT}	Estimated thermal resistance to maximum temperature internal component from isothermal bottom		0.83		°C/W
Thermal capacity				52		Ws/°C
Assembly						
Storage Temperature	T_{ST}	NBM3814x46C15A6yzz (T-Grade)	-40		125	°C
		NBM3814x46C15A6yzz (C-Grade)	-40		125	°C
ESD Withstand	ESD_{HBM}	Human Body Model, "ESDA / JEDEC JDS-001-2012" Class I-C (1kV to < 2 kV)	1000			
	ESD_{CDM}	Charge Device Model, "JESD 22-C101-E" Class II (200V to < 500V)	200			

General Characteristics (Cont.)

Specifications apply over all line, load conditions, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C ≤ T_{CASE} ≤100°C (T-Grade); All other specifications are at T_{CASE} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Safety						
Isolation capacitance	C_{HI_LO}	Unpowered unit	N/A	N/A	N/A	pF
Isolation resistance	R_{HI_LO}	At 500V_{DC}	0			MΩ
MTBF		MIL-HDBK-217Plus Parts Count - 25°C Ground Benign, Stationary, Indoors / Computer		2.2		MHrs
		Telcordia Issue 2 - Method I Case III; 25°C Ground Benign, Controlled		3.6		MHrs
Agency approvals / standards						
		CE Marked for Low Voltage Directive and RoHS Recast Directive, as applicable				