PRM™ Regulator
for Post PFC Operation

PRM48JH480x250A00

High Efficiency Converter

Features

- Optimized for Post PFC operation with 48 V holdup capacitance
- 48.0 V nominal input non-isolated ZVS buck-boost regulator
- Transient operation down to 30.0 V for extended holdup during line dropout
- 20.0 V to 55.0 V adjustable output range
- 250 W output power in 0.57 in^2 footprint
- 96.7% typical efficiency, at full load
- 1676 W/in^3 (102 W/cm^3) Power Density
- 5.29 MHrs MTBF (MIL-HDBK-217 Plus Parts Count)
- Pin selectable operating mode
  - Adaptive Loop
  - Remote Sense / Slave
- Half VI Chip® Package
  - 22.0mm x 16.5mm x 6.73mm
- Optimized for use with PFM based Isolated AC-48 V DC Converters

Typical Applications

- High Density Power Supply AC-DC rail outputs
- High Density ATE system AC-DC power
- Telecom NPU and ASIC core power
- Communications Systems
- Non-isolated and isolated power converters

Product Ratings	
V_{IN} = 45.0 V to 55.0 V	P_{OUT} = 250 W
V_{OUT} = 48.0 V (20.0 V to 55.0 V Trim)	I_{OUT} = 5.21 A

Product Description

The VI Chip® PRM™ Regulator is a high efficiency converter, operating from a 45.0 to 55.0 Vdc input to generate a regulated 20.0 to 55.0 Vdc output. The ZVS buck-boost topology enables high switching frequency (~1.03 MHz) operation with high conversion efficiency. High switching frequency reduces the size of reactive components enabling power density up to 1676 W/in^3.

The Half VI Chip® package is compatible with standard pick-and-place and surface mount assembly processes with a planar thermal interface area and superior thermal conductivity.

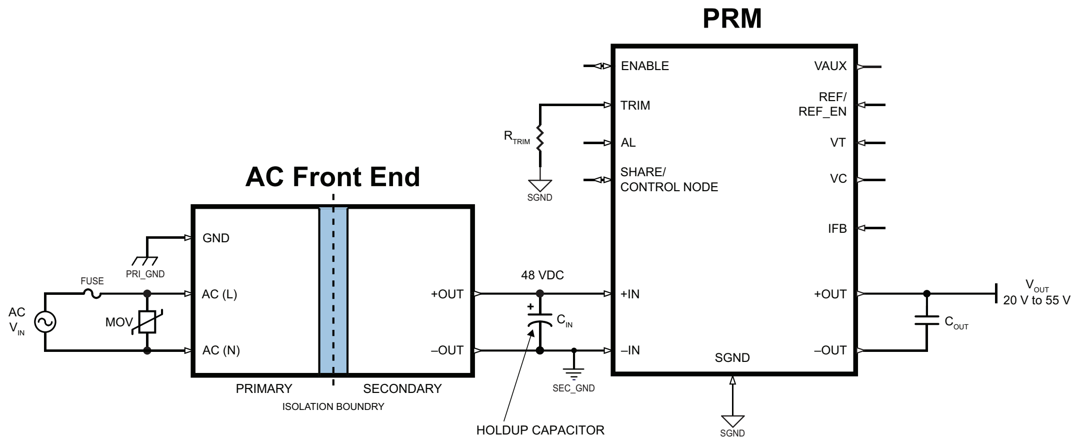
In a Factorized Power Architecture™ system, the PRM and downstream VTM current multiplier minimize distribution and conversion losses in a high power solution, providing an isolated, regulated output voltage.

The PRM48JH480x250A00 has two selectable modes of regulation depending on the application requirements.

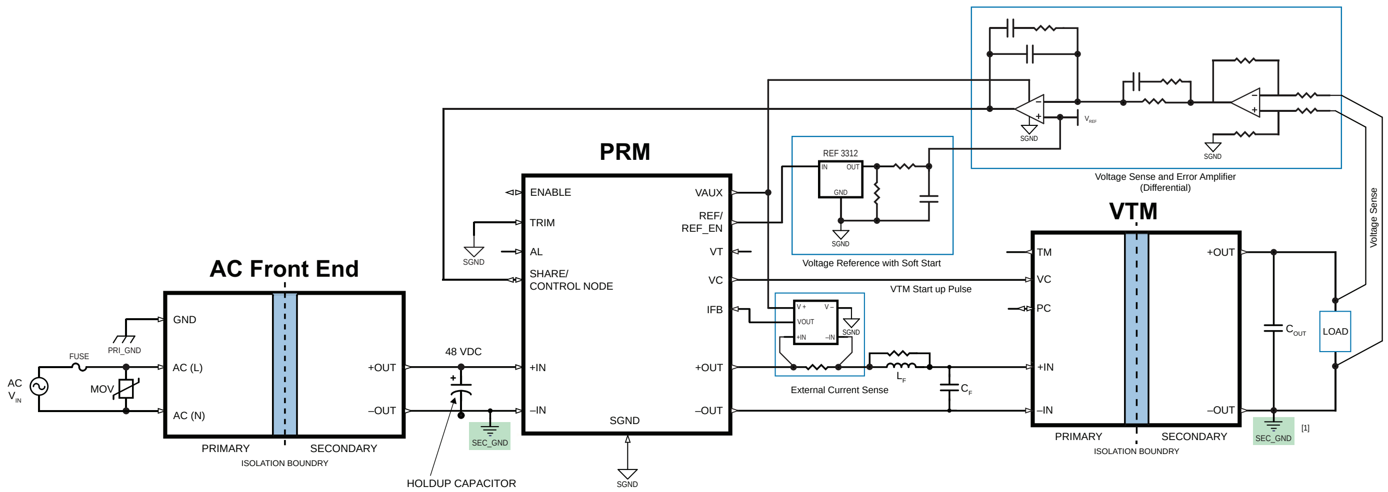
In Adaptive Loop Operation, the PRM48JH480x250A00 utilizes a unique feed-forward scheme that enables precise regulation of an isolated POL voltage without the need for remote sensing and voltage feedback.

In Remote Sense Operation, the internal regulation circuitry is disabled, and an external control loop and current sensor maintain regulation. This affords flexibility in the design of both voltage and current compensation loops to optimize performance in the end application.

Typical Applications



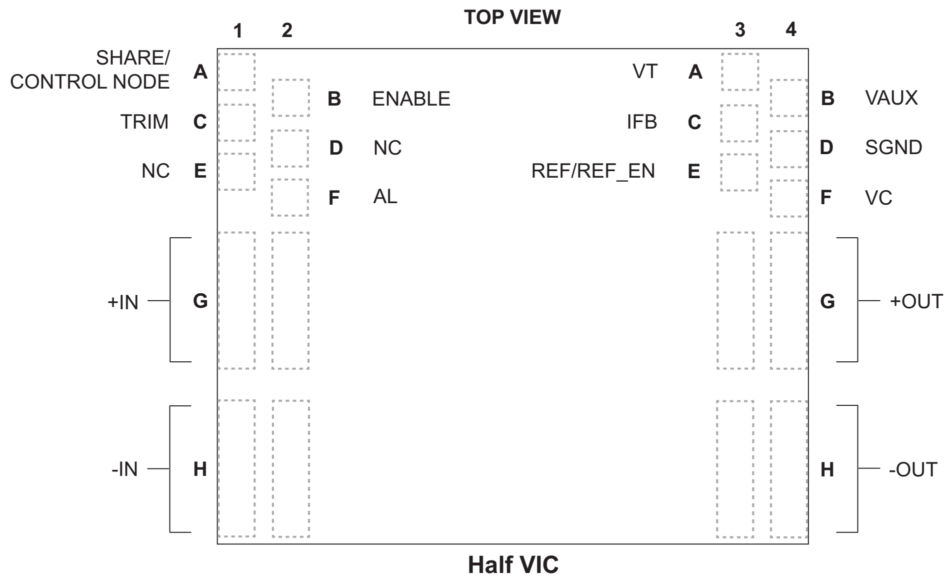
Typical Application: AC-48 VDC Front End + PRM48JH480x250A00



Typical Application: AC-48 VDC Front End + PRM48JH480x250A00 + VTM, non-isolated Remote Sense Configuration

[1] Non-Isolated Configuration: –Out connected to -IN

Pin Configuration



Pin Descriptions

Pin Number	Signal Name	Type	Function
A1	SHARE (Adaptive Loop / Slave Operation)	BIDIR	Parallel sharing control bus for master-slave configuration.
	CONTROL NODE (Remote Sense Operation)	INPUT	Modulator control node input. Driven by external error amplifier in Remote Sense Operation.
A3	VT (Adaptive Loop Operation)	INPUT	VTM TM input for temperature compensation. Leave disconnected for Remote Sense Operation.
B2	ENABLE	BIDIR	Enables power supply when allowed to float high. 5 V during normal operation.
B4	VAUX	OUTPUT	9 V auxiliary bias voltage.
C1	TRIM	INPUT	Selects operating mode. Adjusts output voltage in Adaptive Loop Operation.
C3	IFB (Remote Sense Operation)	INPUT	Current sense input for current limit and overcurrent protection in Remote Sense Operation. Leave disconnected for Adaptive Loop Operation.
D2	NC	n/a	Do not connect this pin.
D4	SGND	INPUT	Signal ground, reference for analog controls. Kelvin connected internally to –IN and –OUT.
E1	NC	n/a	Do not connect this pin.
E3	REF (Adaptive Loop Operation)	OUTPUT	Reference voltage for internal error amplifier in Adaptive Loop Operation.
	REF_EN (Remote Sense Operation)	OUTPUT	Powers and enables external control circuit voltage reference in Remote Sense Operation.
F2	AL (Adaptive Loop Operation)	INPUT	Adaptive loop gain control. Sets the magnitude of the Adaptive Loop load line in Adaptive Loop Operation. Leave disconnected for Remote Sense Operation.
F4	VC	OUTPUT	Bias voltage to power VTM module during start up
G1,G2	+IN	INPUT POWER	Positive input power terminal
G3,G4	+OUT	OUTPUT POWER	Positive output power terminal
H1,H2	-IN	INPUT POWER RETURN	Negative input power terminal. Connected internally to -OUT.
H3,H4	-OUT	OUTPUT POWER RETURN	Negative output power terminal. Connected internally to -IN.

Part Ordering Information

Device	Input Voltage Range	Package Type	Output Voltage x 10	Temperature Grade	Output Power	Revision	Version
PRM	48J	H	480	T	250	A	00
PRM = PRM	48J = 45.0 V - 55.0 V	H = Half VIC SMD	480 = 48.0 V	T = -40 to 125°C M = -55 to 125°C	250 = 250 W	A	00 = AL / RS

Standard Models

Part Number	V_{IN}	Package Type	V_{OUT}	Temperature	Power	Version
PRM48JH480**T**250A00	45.0 V - 55.0 V	Half VIC SMD	48.0 V (20.0 V to 55.0 V)	-40 to 125°C	250 W	AL / RS (Pin Selectable)
PRM48JH480**M**250A00				-55 to 125°C		

Absolute Maximum Ratings

The ABSOLUTE MAXIMUM ratings below are stress ratings only. Operation at or beyond these maximum ratings can cause permanent damage to device. Electrical specifications do not apply when operating beyond rated operating conditions. Operating beyond rated operating conditions for extended period of time may affect device reliability. All voltages are specified relative to SGND unless otherwise noted. Positive pin current represents current flowing out of the pin.

Parameter	Comments	Min	Max	Unit
SHARE / CONTROL NODE		-0.3	10.5	V
			+/-10	mA
ENABLE		-0.3	5.5	V
			+/-10	mA
+IN to –IN	Continuous, non-operating	-1	80	V
	100 ms, non-Operating		100	V
VAUX		-0.5	10.5	V
			+/-100	mA
SGND			+/-100	mA
IFB		-0.5	5.7	V
REF / REF _EN		-0.3	3.6	V
	Remote Sense Operation (REF _EN)		10	mA
	Adaptive Loop Operation (REF)		3.4	mA
TRIM		-0.3	3.6	V
AL		-0.3	3.6	V
VT		-0.3	4.8	V
VC to –OUT		-0.5	18	V
			+/-1.8	A
+OUT to –OUT		-1	62	V
Output Current			7.3	A
Internal Operating Temperature	T Grade	-40	125	°C
	M Grade	-55	125	°C
Storage Temperature	T Grade	-40	125	°C
	M Grade	-65	125	°C

Electrical Specifications

Specifications apply over all line and load conditions, and trim from 20.0 V to 55.0 V, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C < T_{INT} < 125°C; All Other specifications are at T_{INT} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
		Power Input Specification				
Input Voltage Range	V_{IN}	Continuous, operating	**45.0**	48.0	**55.0**	V
Input Voltage Range Transient	V_{IN_TRANS}	Derated current or power supported, 200 ms max, 10% duty cycle max	**30.0**			V
V_{IN} Slew Rate	dV_{IN}/dt	0 ≤ V_{IN} ≤ 55.0 V	**0.001**		**1000**	V/ms
Initialization Voltage	V_{INIT}	Internal micro controller initialization voltage		10		V
Initialization Delay	t_{INIT}	From V_{IN} first crossing V_{INIT}	**5.0**	7.0	**9.0**	ms
No Load Power Dissipation	P_{NL}	ENABLE HIGH, V_{IN} = 48.0 V		2.4	**3.5**	W
Input Quiescent Current	I_{QC}	ENABLE LOW, V_{IN} = 48.0 V		14.5	**20.0**	mA
Input Current	I_{IN_DC}	I_{OUT} = 5.21 A, V_{IN} = 48.0 V, V_{OUT} = 48.0 V		5.4	**5.5**	A
Input Capacitance (Internal)	C_{IN_INT}	Effective value, V_{IN} = 48.0 V (see Fig. 13)		2		µF
Input Capacitance (Internal) ESR	R_{CIN}	Effective value, V_{IN} = 48.0 V		3.0		m
		Power Output Specification				
Rated Output Current	I_{OUT}	Standalone and Master Operation, see Figure 1, SOA			**5.21**	A
Rated Output Power	P_{OUT}	Standalone and Master Operation, see Figure 1, SOA			**250**	W
Switching Frequency	F_{SW}	V_{IN} = 48.0 V V_{OUT} = 48.0 V, I_{OUT} = 2.60 A, T_{INT} = 25°C	0.94	1.03	1.07	MHz
		Over line, load, trim and temperature, exclusive of burst mode	**0.70**		**1.07**	MHz
Output Turn-ON Delay	t_{ON}	From V_{IN} first crossing $V_{IN\_UVLO+\_SUPV}$ to ENABLE high; t_{INIT} expired		20		µs
		From ENABLE pin release to ENABLE high, V_{IN} applied, t_{OFF} expired		20		µs
Start up Sequence Timeout	$t_{STARTUP\_SEQ}$	From ENABLE high to start up sequence complete		17		ms
Efficiency Ambient	AMB	V_{IN} = 48.0 V, V_{OUT} = 48.0 V, I_{OUT} = 5.21 A, T_{INT} = 25°C	95.7	96.7		%
		V_{IN} = 48.0 V, V_{OUT} = 48.0 V, I_{OUT} = 2.60 A, T_{INT} = 25°C	94.5	95.7		%
		V_{IN} = 45.0 V to 55.0 V, V_{OUT} = 48.0 V, I_{OUT} = 5.21 A, T_{INT} = 25°C	95.1			%
		V_{IN} = 45.0 V to 55.0 V, I_{OUT} = 5.21 A, T_{INT} = 25°C, over trim	92.0			%
Efficiency Hot	HOT	V_{IN} = 48.0 V, V_{OUT} = 48.0 V, I_{OUT} = 5.21 A, T_{INT} = 100°C	95.5	96.5		%
		V_{IN} = 48.0 V, V_{OUT} = 48.0 V, I_{OUT} = 2.60 A, T_{INT} = 100°C	94.5	95.8		%
		V_{IN} = 45.0 V to 55.0 V , V_{OUT} = 48.0 V, I_{OUT} = 5.21 A, T_{INT} = 100°C	94.8			%
		V_{IN} = 45.0 V to 55.0 V , I_{OUT} = 5.21 A, T_{INT} = 100°C, over trim	91.3			%
Efficiency Over Temperature		>50% load and V_{OUT} = 48.0 V; over temperature	**94.0**			%
		>50% load; over temperature and trim	**89.2**			%
Output Discharge current	I_{OD}	Average Value		0.5		mA
Output Voltage Ripple	V_{OUT_PP}	V_{IN} = 48.0 V, V_{OUT} = 48.0 V, I_{OUT} = 5.21 A, C_{OUT_EXT} = 0 F, 20 MHz BW		1110	**1665**	mV
Output Inductance (Parasitic)	L_{OUT_PAR}	Frequency @ 1.03 MHz, Simulated J-Lead model		2.5		nH
Output Capacitance (Internal)	C_{OUT_INT}	Effective value, V_{OUT} = 48.0 V (see Fig.13)		2		µF
Output Capacitance (Internal) ESR	R_{COUT}	Effective value, V_{OUT} = 48.0 V		3.0		m

Electrical Specifications (cont.)

Specifications apply over all line and load conditions, and trim from 20.0 V to 55.0 V, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C < T_{INT} < 125°C; All Other specifications are at T_{INT} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Power Output Specifications: Adaptive Loop Operation						
Output Voltage Setpoint	V_{OUT_SET}	No load, trim Inactive, Adaptive Loop load line inactive	**47.00**	48.00	**49.00**	V
Output Voltage Trim Range	V_{OUT}		**20.0**		**55.0**	V
Output Voltage Rise Time	t_{RISE_VOUT}	From soft start initiated to output voltage settled	**1.7**	1.8	**1.9**	ms
Output Voltage Load Regulation	$V_{OUT\_REG\_LOAD}$	Adaptive loop load line inactive		0.02	**0.2**	%
Output Voltage Line Regulation	$V_{OUT\_REG\_LINE}$	Adaptive loop load line inactive		0.02	**0.2**	%
Total Regulation Error	$V_{OUT\_REG\_TOTAL}$	PRM output voltage, Adaptive Loop load line inactive			**0.2**	%
Total AL Regulation Error	$V_{OUT\_REG\_AL}$	VTM output voltage, total Adaptive Loop regulation, V_{OUT} = 48.0 V, trim inactive		1	**3**	%
		VTM output voltage, total Adaptive Loop regulation, trim active, exclusive of external resistor tolerances			**5**	%
Line Frequency Ripple Rejection	$PSRR_{120HZ}$	120Hz, C_{OUT_EXT} = 0 F, I_{OUT} = 2.60 A		60		dB
Output Current Limit	I_{LIMIT}	V_{IN} = 48.0 V, V_{OUT} = 48.0 V, T_{INT} = 25°C, constant current limit after supervisory limit detection time t_{LIM_SUPV}	5.7	6.5	7.3	A
		Over line, load, trim and temperature	**5.45**		**7.75**	A
Load Capacitance (Electrolytic)	C_{LOAD_ALEL}	0.1 ≤ ESR ≤ 1 , See Figure 32, total capacitance (C_{LOAD_ALEL} + C_{LOAD_CER}) ≤ 47 µF			**47**	µF
Load Capacitance (Ceramic)	C_{LOAD_CER}	2 m ≤ ESR ≤ 200 m , See Figure 32			**25**	µF
Load Transient Voltage Deviation	V_{TRANS}	10% ↔ 100% load step, 10 A/µsec, 0 µF C_{OUT}, deviation from initial setpoint			**4.8**	V
Load Transient Recovery Time	t_{TRANS}	10% ↔ 100% load step, 10 A/µsec, 0 µF C_{OUT}, Recovery to 90% of final value, Adaptive Loop load line inactive		100		µs
		10% ↔ 100% load step, 10 A/µsec, 0 µF C_{OUT}, Recovery to 90% of final value, Adaptive Loop load line active, V_{AL} = 0.96 V		500		µs
Power Output Specifications: Slave Operation with AL Master						
Rated Current Within an Array	I_{OUT_ARRAY}	Slave Operation within an array, up to 5°C case temperature differential, master-slave configuration			**4.2**	A
		Slave Operation within an array, up to 30°C case temperature differential, master-slave configuration			**3.6**	A
Rated Power Within an Array	P_{OUT_ARRAY}	Slave Operation within an array, up to 5°C case temperature differential, master-slave configuration			**200**	W
		Slave Operation within an array, up to 30°C case temperature differential, master-slave configuration			**175**	W
Current Sharing Difference (Master to Slave)	$I_{OUT\_SHARE\_MS}$	Equal input, and output voltage at full load; V_{IN} = 48.0 V, V_{OUT} = 48.0 V			**15**	%
		Equal input and output voltage at full load; Over line and trim, with 25°C ≤ T_C ≤ 100°C and ≤ 5°C part-part temp. mismatch			15	%
		Equal input, and output voltage at full load; Over line and trim, with 25°C ≤ T_C ≤ 100°C and ≤ 30°C part-part temp. mismatch			20	%

Electrical Specifications (cont.)

Specifications apply over all line and load conditions, and trim from 20.0 V to 55.0 V, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C < T_{INT} < 125°C; All Other specifications are at T_{INT} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Powertrain Protections						
Input Undervoltage Turn-ON	V_{IN_UVLO+}			24.5	**26.0**	V
Input Undervoltage Turn-OFF	V_{IN_UVLO-}	Instantaneous powertrain shutdown, detected after t_{BLANK}	**22.0**	22.7		V
Input Undervoltage Hysteresis	V_{UVLO_HYST}	(V_{IN_UVLO+}) - (V_{IN_UVLO-})	**1.8**	2.2	**2.5**	V
Input Overvoltage Turn-ON	V_{IN_OVLO-}		**56.0**	62.6		V
Input Overvoltage Turn-OFF	V_{IN_OVLO+}	Instantaneous powertrain shutdown, detected after t_{BLANK}		63.6	**67.3**	V
Input Overvoltage Hysteresis	V_{OVLO_HYST}	(V_{IN_OVLO+}) - (V_{IN_OVLO-})	**0.7**	1.0	**1.4**	V
Output Overvoltage Threshold	V_{OUT_OVP+}	Instantaneous shutdown, detected after t_{PROT}	**56.0**	57.9	**60.0**	V
Minimum Current Limited Vout	V_{OUT_UVP}				**12**	V
Overtemperature Shutdown Setpoint	T_{INT_OTP}	Instantaneous shutdown, detected after t_{PROT}	**125**			°C
Output Power Limit	P_{PROT}		**250**			W
Short Circuit V_{OUT} Threshold	V_{SC_VOUT}			8.8		V
Short Circuit V_{OUT} Recovery Threshold	V_{SC_VOUTR}			9.5		V
Short Circuit CONTROL NODE Threshold	V_{SC_VCN}			7.2		V
Short Circuit CONTROL NODE Recovery Threshold	V_{SC_VCNR}			6.9		V
Short Circuit Timeout	t_{SC}	Short circuit fault detected after V_{SC_VOUT} and V_{SC_VCN} thresholds persist for this time		5		ms
Short Circuit Recovery Time	t_{SCR}	Excludes t_{OFF}		75		ms
Overcurrent (IFB) and Input Over/Undervoltage Blanking Time	t_{BLANK}		**50**	130	**160**	µs
Overtemperature, Output Overvoltage and ENABLE Shutdown Response Time (Hardware)	t_{PROT}			2		µs
Powertrain Supervisory Limits						
Input Undervoltage Turn-ON (Supervisory)	$V_{IN\_UVLO+\_SUPV}$			42.3	**44.0**	V
Input Undervoltage Turn-OFF (Supervisory)	$V_{IN\_UVLO-\_SUPV}$	Powertrain shutdown, detected after t_{LIM_SUPV}	**23.5**	25.7		V
Input Undervoltage Hysteresis (Supervisory)	$V_{UVLO\_HYST\_SUPV}$	($V_{IN\_UVLO+\_SUPV}$) - ($V_{IN\_UVLO-\_SUPV}$)	**14.2**	16.7	**19.2**	V
Input Overvoltage Turn-ON (Supervisory)	$V_{IN\_OVLO-\_SUPV}$		**56.0**	57.7		V
Input Overvoltage Turn-OFF (Supervisory)	$V_{IN\_OVLO+\_SUPV}$	Powertrain shutdown, detected after t_{LIM_SUPV}		58.9	**60.0**	V
Input Overvoltage Hysteresis (Supervisory)	$V_{OVLO\_HYST\_SUPV}$	($V_{IN\_UVLO+\_SUPV}$) - ($V_{IN\_UVLO-\_SUPV}$)	**0.8**	1.2	**1.7**	V
Undertemperature Shutdown Setpoint (Supervisory)	T_{INT_UTP}	T Grade			-40	°C
		M Grade			-55	°C
Supervisory Limit Response Time	t_{LIM_SUPV}				**150**	µs

Electrical Specifications (cont.)

Specifications apply over all line and load conditions, and trim from 20.0 V to 55.0 V, unless otherwise noted; **Boldface** specifications apply over the temperature range of -40°C < T_{INT} < 125°C; All Other specifications are at T_{INT} = 25°C unless otherwise noted.

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Power Output Specifications: Slave Operations (cont.)						
Current Sharing Difference (Slave to Slave)	$I_{OUT\_SHARE\_SS}$	Equal input, output, and SHARE voltage at full load; V_{IN} = 48.0 V, V_{OUT} = 48.0 V			**5**	%
		Equal input, output and SHARE voltage at full load; Over line and trim, with 25°C ≤ T_C ≤ 100°C and ≤ 5°C part-part temp. mismatch			10	%
		Equal input, output, and SHARE voltage at full load; Over line and trim, with 25°C ≤ T_C ≤ 100°C and ≤ 30°C part-part temp. mismatch			15	%
Maximum Array Size	$N_{PRMS\_PARALLEL}$	Maximum number of parallel devices, master-slave configuration			**5**	PRMs
Power Output Specifications: Remote Sense Operation						
Output Voltage Range	V_{OUT}		**20.0**		**55.0**	V
Rated Current Within an Array	I_{OUT_ARRAY}	Remote Sense Operation within an array, up to 5°C case temperature differential			**4.7**	A
		Remote Sense Operation within an array, up to 30°C case temperature differential			**4.2**	A
Rated Power Within an Array	P_{OUT_ARRAY}	Remote Sense Operation within an array, up to 5°C case temperature differential			**225**	W
		Remote Sense Operation within an array, up to 30°C case temperature differential			**202**	W
Current Sharing Difference	$I_{OUT\_SHARE\_RS}$	Equal input, output, and CONTROL NODE voltage at full load; V_{IN} = 48.0 V, V_{OUT} = 48.0 V			**5**	%
		Equal input, output and CONTROL NODE voltage at full load; Over line and trim, with 25°C ≤ T_C ≤ 100°C and ≤ 5°C part-part temp. mismatch			10	%
		Equal input, output, and CONTROL NODE voltage at full load; Over line and trim, with 25°C ≤ T_C ≤ 100°Cand ≤ 30°C part-part temp. mismatch (worst case)			15	%
Maximum Array Size	$N_{PRMS\_PARALLEL}$	Maximum number of parallel devices, Remote Sense configuration, CONTROL NODE externally driven			**10**	PRMs

Line Dropout Characteristics

Specifications apply during a line dropout condition V_{IN} from 30.0 V to 38.0 V , and trim from 20 V to 55 V, unless otherwise noted;
Boldface specifications apply over the temperature range of -40 °C < T_{INT} < 125°C (T-grade).

Line Dropout Specifications

- After startup if V_{IN} drops below $V_{IN\_DROPOUT\_EN-}$, a 200 msec line dropout timer is enabled
- Operation is sustained down to 30.0 V with specified derating for duration of timer
- Line dropout timer is disabled and normal operation resumes when V_{IN} recovers above $V_{IN\_DROPOUT\_DIS+}$
- Powertrain shutdown is initiated if V_{IN} does not recover to above $V_{IN\_DROPOUT\_DIS+}$ before the timer expires or if Vin falls below $V_{IN\_UVLO-\_SUPV}$

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Line Dropout Timer Enable Threshold	$V_{IN\_DROPOUT\_EN-}$	Line dropout timer activated when input voltage drops **below** this level	**37.0**	38.0		V
Line Dropout Timer Disable Threshold	$V_{IN\_DROPOUT\_DIS+}$	Line dropout timer disabled when input voltage recovers **above** this level		38.0	**39.0**	V
Line Dropout Timer Duration	$t_{DROPOUT}$	Powertrain shutdown after timer expires	**190**	200		ms
Line Dropout Minimum Operating Voltage	$V_{IN\_DROPOUT\_MIN}$	Minimum input voltage for sustained operation	**30.0**			V
Line Dropout Current Rating	$\%I_{DROPOUT}$	Percentage of rated current, linearly derated to 75% between 38.0 V and 30.0 V, see Figure 41	-18.75 + 3.13 x V_{IN}			%
Line Dropout Power Rating	$\%P_{DROPOUT}$	Percentage of rated current, linearly derated to 75% between 38.0 V and 30.0 V, see Figure 41	-18.75 + 3.13 x V_{IN}			%

Signal Specifications

Specifications apply over all line and load conditions, T_{INT} = 25°C and output voltage from 20.0 V to 55.0 V, unless otherwise noted.
Boldface specifications apply over the temperature range of -40°C < T_{INT} < 125°C (T-grade).

ENABLE

- The ENABLE pin enables and disables the PRM
- In PRM array configurations, ENABLE pins should be connected in order to synchronize start up
- ENABLE is 5 V with 1.8 mA source capability during normal operation

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Output	Normal Operation	ENABLE Voltage	V_{ENABLE}		**4.7**	5.0	**5.3**	V
		ENABLE Current	I_{ENABLE_OP}				**1.8**	mA
	Start up	ENABLE Source Current	I_{ENABLE_EN}	After t_{OFF}		90		µA
		Minimum Time to Start	t_{OFF}		**13.0**	15.0	**17.0**	ms
Digital Input / Output	Start up	ENABLE Enable Threshold	V_{ENABLE_EN}			2.5	**3.2**	V
	Standby	ENABLE Disable Threshold	V_{ENABLE_DIS}		**0.97**	2.40		V
		ENABLE Resistance (External)	R_{ENABLE_EXT}	Resistance to SGND required to disable the PRM			**235**	
Digital Output	Fault	ENABLE Sink Current to SGND	I_{ENABLE_FAULT}	ENABLE voltage 1 V or above			**4**	mA

VAUX: Auxillary Voltage Source

- Intended to power auxiliary circuits
- 9 V during normal operation with 5 mA source capability

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Output	Normal Operation	VAUX Voltage	V_{VAUX}		**8.6**	9.0	**9.5**	V
		VAUX Current	I_{VAUX}				**5**	mA
		VAUX Voltage Ripple	V_{VAUX_PP}	I_{OUT} = 0A, C_{VAUX_EXT} = 0. Maximum specification includes powertrain operation in burst mode.		100	**400**	mV
	Transition	VAUX Capacitance (External)	C_{VAUX_EXT}				**0.04**	µF
		VAUX Fault Response Time	t_{FR_VAUX}	From fault recognition to VAUX = 1.5 V		30		µs

VC: VTM Control

- Pulsed voltage source used to power and synchronize downstream VTM during start up
- 14 V, 10 ms typical voltage pulse

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Output	Start up	VC Voltage	V_{VC_START}	Connected to VTM VC or equivalent, I_{VC} = 115 mA, C_{VC} = 3.2 uF	**13**	14	**18**	V
		VC Available Current	I_{VC_START}	V_C = 14 V, V_{IN} > 20 V	**200**			mA
		VC Duration	t_{VC}		**7**	10	**16**	ms
		VC Slew Rate	dVC/dt	Connected to VTM or equivalent, I_{VC} = 115 mA, C_{VC} = 3.2 uF	**0.02**		**0.25**	V/µs
		ENABLE to VC Delay	$t_{ENABLE\text{-}VC}$			20		µs

Signal Specifications (cont.)

Specifications apply over all line and load conditions, T_{INT} = 25°C and output voltage from 20.0 V to 55.0 V, unless otherwise noted.
Boldface specifications apply over the temperature range of -40°C < T_{INT} < 125°C (T-grade).

SGND: Signal Ground

- All control signals must be referenced to this pin, with the exception of VC
- SGND is internally connected to -IN and -OUT

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Input / Output	Any	Maximum Allowable Current	I_{SGND}		**-100**		**100**	mA

TRIM

- TRIM is used to select operating mode and trim the output voltage in Adaptive Loop Operation
- Internal pullup to V_{CC_INT} through 10 k resistor
- When pulled below 0.45 V during power up, Remote Sense / Slave Operation is selected
- When allowed to pull up above 0.55 V during power up, Adaptive Loop Operation is selected
- Operating mode is detected during power up and cannot be changed unless input power is cycled

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Input	Normal Operation	Internally Generated VCC	V_{CC_INT}		**3.20**	3.28	**3.36**	V
		Internal Pullup Resistance to V_{CC_INT}	R_{TRIM_INT}	0.5% tolerance resistor	**9.83**	10.00	**10.18**	k
	Mode Detect	Mode Detection Delay	t_{MODE_DETECT}	From ENABLE high to mode detected, after V_{IN} first applied	**100**	150	**200**	µs
		Remote Sense Enable Threshold	$V_{RS\_MODE\_EN}$	Pull **below** this value during first start up after application of power to enable Remote Sense / Slave Operation	**0.45**			V
		Remote Sense Disable Threshold	$V_{RS\_MODE\_DIS}$	Pull **above** this value during first start up after application of power to enable Adaptive Loop Operation			**0.55**	V

Signal Specifications (cont.)

Specifications apply over all line and load conditions, T_{INT} = 25°C and output voltage from 20.0 V to 55.0 V, unless otherwise noted.
Boldface specifications apply over the temperature range of -40°C < T_{INT} < 125°C (T-grade).

TRIM (Adaptive Loop Operation Only)

- Provides dynamic trim control over the PRM output voltage in Adaptive Loop Operation
- Sampled prior to every start up to detect if trim is active or inactive
- Output voltage is equal to 20 times the voltage at the TRIM pin when applied TRIM voltage is within the active range
- Trim state is detected during normal operation and cannot be changed until start up is initiated

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Input	Start up	Trim Enable Threshold	V_{TRIM_EN}	Pull **below** this value during start up to enable trim control	**3.10**			V
		Trim Disable Threshold	V_{TRIM_DIS}	Pull **above** this value during start up to disable trim control			**3.20**	V
		Minimum Trim Disable Resistance	$R_{TRIM\_DIS\_MIN}$	Minimum TRIM resistance required to disable trim	**10**			M
		Trim Capacitance (External)	C_{TRIM_EXT}				**100**	pF
		Trim Sample Delay	t_{ENABLE_TRIM}	From ENABLE high to TRIM sampled	**100**	150	**200**	µs
	Normal Operation	TRIM Pin Analog Range	V_{TRIM_RANGE}	See Figure 26	**1.00**		**2.75**	V
		TRIM Gain	G_{TRIM}	V_{OUT} / V_{TRIM}, V_{TRIM} applied within active range		20		V / V
		Trim Accuracy	$\%_{ACC\_TRIM}$	Vout accuracy, exclusive of external resistor tolerance		0.5	**2.0**	%
		V_{OUT} Referred Trim Resolution	V_{OUT_RES}			200		mV
		Trim Latency	t_{TRIM_LAT}		**65**	130	**260**	µs
		Trim Bandwidth	BW_{TRIM}	-3dB point		1.2		kHz

Signal Specifications (cont.)

Specifications apply over all line and load conditions, T_{INT} = 25°C and output voltage from 20.0 V to 55.0 V, unless otherwise noted.
Boldface specifications apply over the temperature range of -40°C < T_{INT} < 125°C (T-grade).

AL: Adaptive Loop (Adaptive Loop Operation Only)

- Provides Adaptive Loop load line programming in Adaptive Loop Operation
- Internal pullup to V_{CC_INT} through 10 k resistor
- Sampled prior to every start up to detect if Adaptive Loop load line is active or inactive
- Leave open to disable Adaptive Loop load line
- Not used in Remote Sense Operation

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Input	Start up	AL Enable Threshold	V_{AL_EN}	Pull **below** this value during start up to enable AL load line	**3.10**			V
		AL Disable Threshold	V_{AL_DIS}	Pull **above** this value during start up to disable AL load line			**3.20**	V
		Minimum AL Disable Resistance	$R_{AL\_DIS\_MIN}$	Minimum AL resistance required to disable AL load line	**10**			M
		AL Capacitance (External)	C_{AL_EXT}				**100**	pF
		AL Sample Delay	t_{ENABLE_AL}	From ENABLE high to AL sampled	**100**	150	**200**	µs
	Normal Operation	Internally generated VCC	V_{CC_INT}		**3.20**	3.28	**3.36**	V
		Internal Pullup Resistance to V_{CC_INT}	R_{AL_INT}	0.5% tolerance resistor	**9.83**	10.00	**10.18**	k
		AL Pin Analog Range	V_{AL_RANGE}		**0**		**3.10**	V
		AL Gain	G_{AL}	Positive correction slope, VT inactive		1.0		/V
		AL Load Line Accuracy	$\%_{ACC\_LL\_AL}$	Full load slope accuracy exclusive of external resistor tolerance		0.5	**2.0**	%
		AL Load Line Resolution	LL_{AL_RES}			3		m
		Maximum Output Referred Compensation	$V_{OUT\_AL\_MAX}$	Maximum increase from no load setpoint, V_{OUT} ≤ 55.0 V			**5**	V
		AL Latency	t_{AL_LAT}		**65**	130	**260**	µs
		AL Bandwidth	BW_{AL}	-3dB point		1.2		kHz

Signal Specifications (cont.)

Specifications apply over all line and load conditions, T_{INT} = 25°C and output voltage from 20.0 V to 55.0 V, unless otherwise noted.
Boldface specifications apply over the temperature range of -40°C < T_{INT} < 125°C (T-grade).

VT: VTM Temperature (Adaptive Loop Operation Only)

- VTM temperature compensation for Adaptive Loop regulation
- Adjusts the slope of the Adaptive Loop load line to account for changes in VTM output resistance over temperature
- Connect to TM pin of compatible downstream VTM to enable temperature compensation
- Leave disconnected to disable temperature compensation

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Input	Normal Operation	Internal Resistance to SGND	R_{VT_INT}			80.4		k
		VT Enable Threshold	V_{VT_EN}				**2.1**	V
		VT Disable Threshold	V_{VT_DIS}	Pull below this value to disable VT temperature compensation	**1.9**			V
		VT Disable Default Temperature	T_{VT_DIS}	Default AL temperature setting when VT disabled		25		°C
		VT Analog Range	V_{VT_OP}		**2.18**		**3.98**	V
		VT Temperature Coefficient	TC_{VT}	VT within active range, referenced to 2.98 V		30		%/V
			TC_{VT}	VTM TM voltage applied, .01V/°K, referenced to 25°C		0.3		%/C
		VT Resolution	TC_{VT_RES}	VTM TM voltage applied, .01V/°K		0.4		°C
		VT Latency	t_{VT_LAT}		**65**	130	**260**	µs
		Bandwidth	BW_{VT}	-3dB point		1.5		kHz

REF: Reference (Adaptive Loop Operation Only)

- Functions as REF pin in Adaptive Loop Operation
- REF represents the internal voltage reference for the voltage control circuit
- V_{OUT} approximately equal to 20 times REF voltage

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Output	Normal Operation	REF Voltage	V_{REF}	V_{OUT} = 48.0 V, trim inactive		2.4		V
		REF to V_{OUT} Scale Factor	G_{REF_VOUT}	V_{OUT} / V_{REF}		20		V / V
		REF Resistance (External)	R_{REF_EXT}		**10**			M
		REF Capacitance (External)	C_{REF_EXT}				**200**	pF
		REF Voltage Ripple	V_{REF_PP}	Includes burst mode, 20 MHz BW		25		mV
	Transition	ENABLE to REF Delay	t_{ENABLE_REF}	ENABLE low to REF low		130		µs
		VAUX to REF Delay	t_{VAUX_REF}	VAUX = 8.1 V to REF soft start ramp initiated		1		ms

Signal Specifications (cont.)

Specifications apply over all line and load conditions, T_{INT} = 25°C and output voltage from 20.0 V to 55.0 V, unless otherwise noted.
Boldface specifications apply over the temperature range of -40°C < T_{INT} < 125°C (T-grade).

REF_EN: Reference Enable (Remote Sense and Slave Operation Only)

- Functions as REF_EN pin in Remote Sense and Slave Operation
- REF_EN signals successful start up and powertrain ready to operate
- Intended to power and enable the external feedback circuit reference in Remote Sense Operation
- 3.25 V, 4 mA regulated voltage source

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Output	Normal Operation	REF_EN Voltage	V_{REF_EN}	REF_EN unloaded	**2.72**	3.25	**3.37**	V
		REF_EN Source Impedance	$R_{OUT\_REF\_EN}$			50	**100**	
		REF_EN Current	I_{REF_EN}				**4**	mA
		REF_EN Capacitance (External)	$C_{REF\_EN\_EXT}$				**0.1**	µF
		REF_EN Voltage Ripple	$V_{REF\_EN\_PP}$	Includes burst mode, 20 MHz BW		25		mV
	Transition	ENABLE to REF_EN Delay	$t_{ENABLE\_REF\_EN}$	ENABLE low to REF_EN low		130		µs
		VAUX to REF_EN Delay	$t_{VAUX\_REF\_EN}$	VAUX = 8.1 V to REF_EN high		1		ms

Share (Adaptive Loop and Slave Operation Only)

- Functions as SHARE pin in master slave array configuration
- Current share bus for array operation (master/slave scheme)
- Sources current and provides SHARE signal in master operation
- Sinks constant current when externally driven in active range (Slave Operation)

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Output	Standalone/ Master Operation	SHARE Voltage Active Range	V_{SHARE}		**0.79**		**7.40**	V
		SHARE Available Current	I_{SHARE}	V_{SHARE} > 0.79 V	**2.5**			mA
		SHARE Resistance to SGND	R_{SHARE}			93.3		k
Analog Input	Slave Operation	SHARE Sink Current	I_{SHARE_SINK}	V_{SHARE} > 0.79 V	**0.25**	0.50	**0.75**	mA

Signal Specifications (cont.)

Specifications apply over all line and load conditions, T_{INT} = 25°C and output voltage from 20.0 V to 55.0 V, unless otherwise noted.
Boldface specifications apply over the temperature range of -40°C < T_{INT} < 125°C (T-grade).

Control Node (Remote Sense Operation Only)

- Functions as CONTROL NODE pin in Remote Sense Operation
- Modulator control node voltage sets power train timing
- Driven by external error amplifier in Remote Sense Operation
- Sinks constant current when externally driven in active range
- Sources current, and clamps voltage to 0.79 V when pulled below active range

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Input	Normal Operation	CONTROL NODE Voltage Active Range	V_{CN}		**0.79**		**7.40**	V
		CONTROL NODE Source Current	I_{CN_LOW}	V_{CN} < 0.79 V			**2.5**	mA
		CONTROL NODE Sink Current	I_{CN_SINK}	V_{CN} > 0.79 V	**0.25**	0.50	**0.75**	mA
		CONTROL NODE Resistance to SGND	R_{CN}			93.3		k

IFB: Current Feedback (Remote Sense Operation Only)

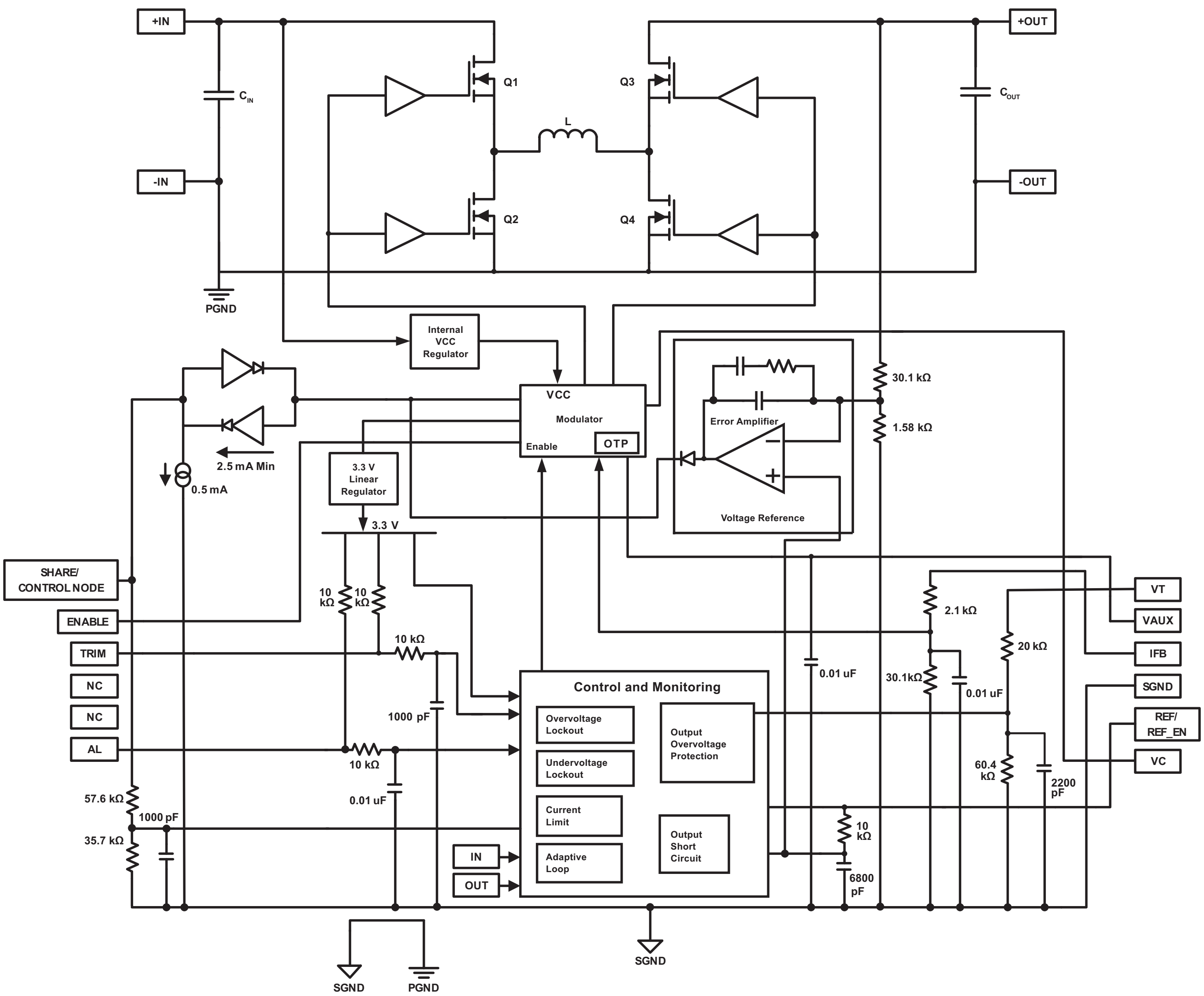
- Functions as IFB pin in Remote Sense Operation
- A voltage proportional to the PRM output current must be supplied externally to the IFB pin in order for the device to properly protect overcurrent events and to enable output current limit (clamp)
- Overcurrent protection trip will cause instantaneous powertrain disable, detected after t_{BLANK}
- Not used for Adaptive Loop Operation

Signal Type	State	Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
Analog Input	Normal Operation	Current Limit (Clamp) Threshold	V_{IFB_IL}	V_{IN} = 48.0 V; V_{OUT} = 48.0 V T_{INT} = 25°C	1.90	2.00	2.10	V
				Over line, trim, and temperature	**1.85**		**2.15**	V
		Overcurrent Protection Threshold	V_{IFB_OC}	Not production tested; guaranteed by design; T_{INT} = 25°C	**2.58**	2.69	**2.80**	V
				Not production tested; guaranteed by design; over line, trim, and temperature	**2.56**		**2.82**	V
		IFB Input Impedance	R_{IFB}		**2.09**	2.13	**2.17**	k
		Current Limit Bandwidth	BW_{IL}			2.0		kHz

NC: No Connect

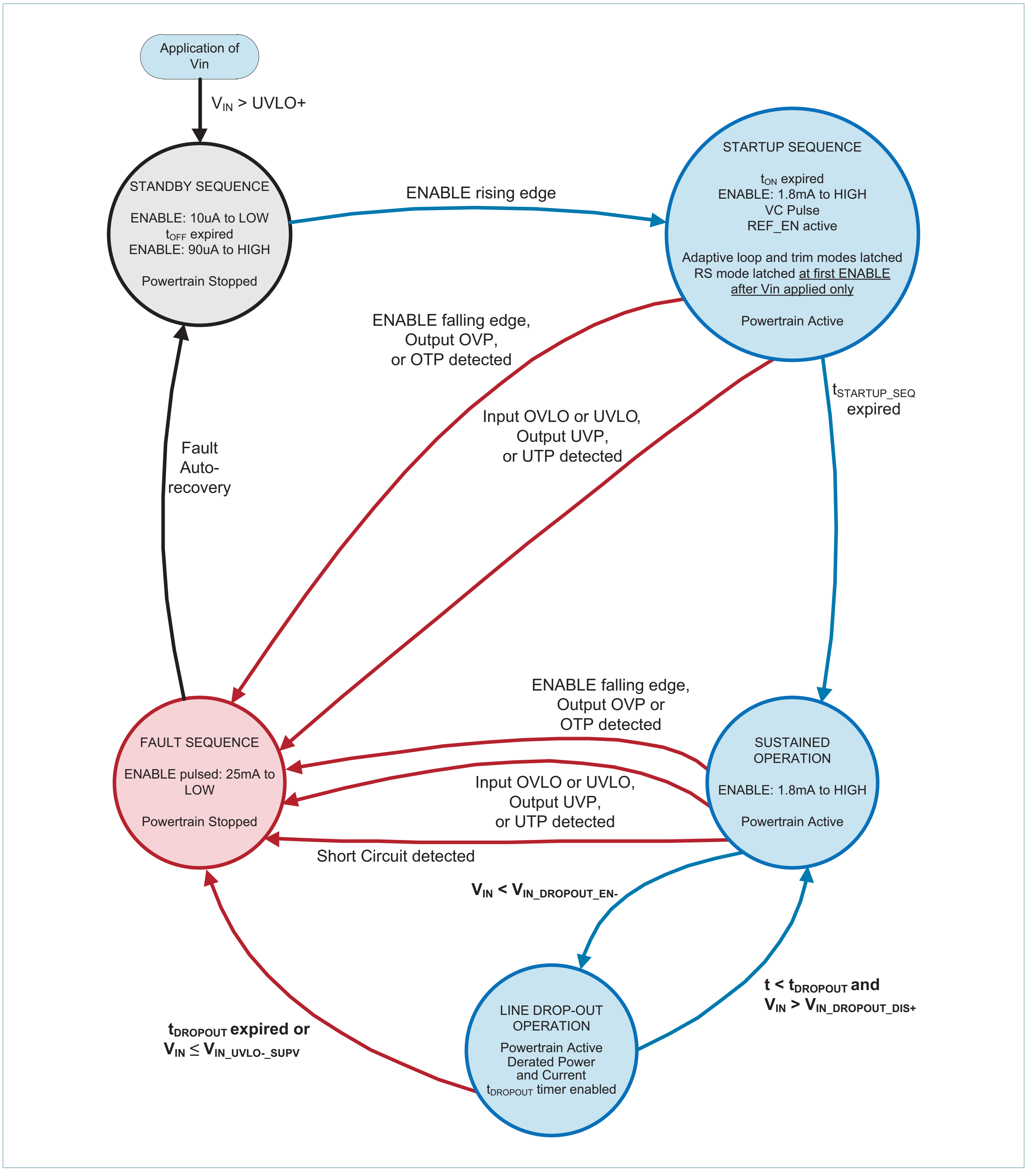
- Reserved for factory use only
- No connections should be made to these pins

Functional Block Diagram



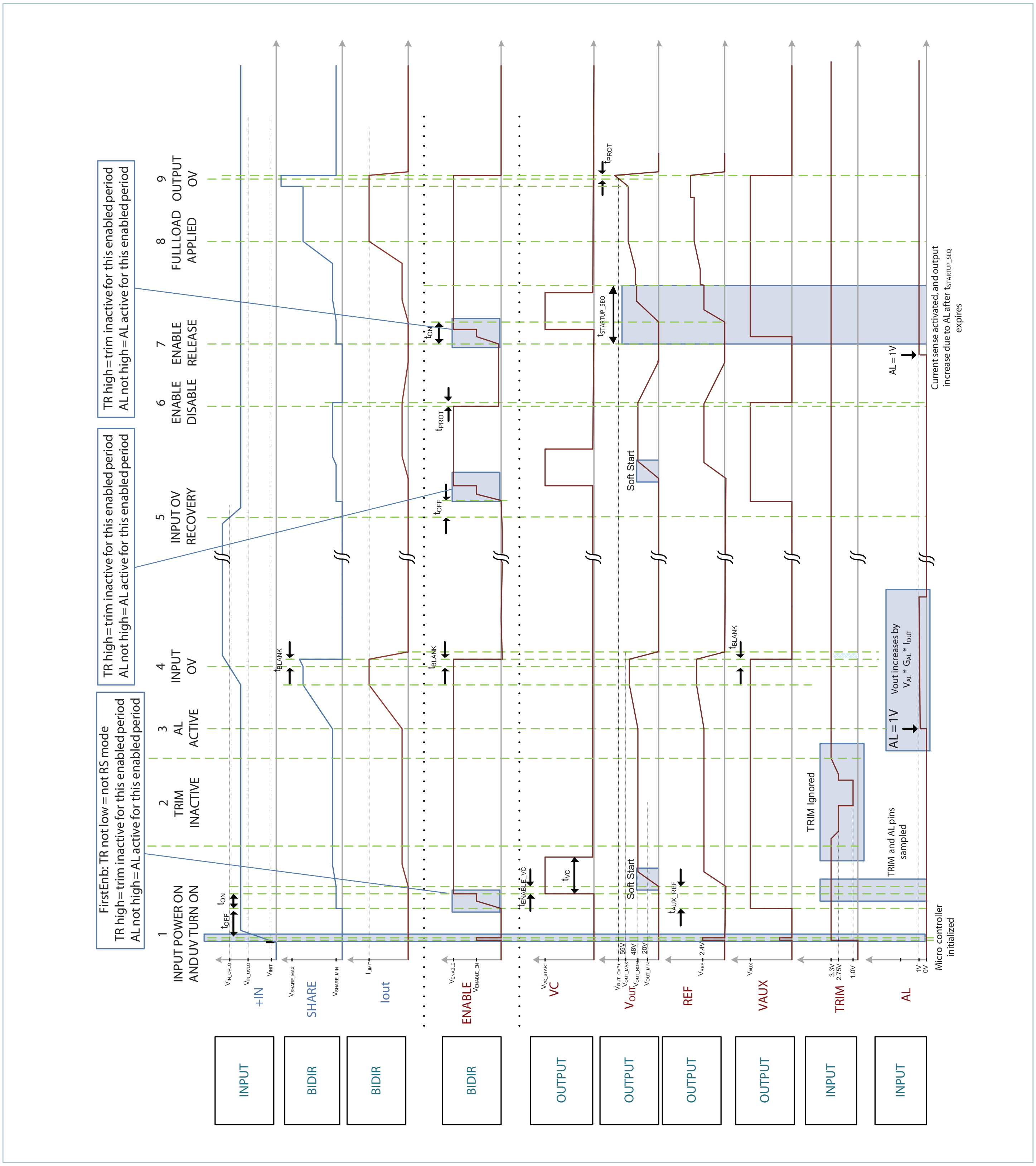
High Level Functional State Diagram

Conditions that cause state transitions are shown along arrows. Sub-sequence activities listed inside the state bubbles.



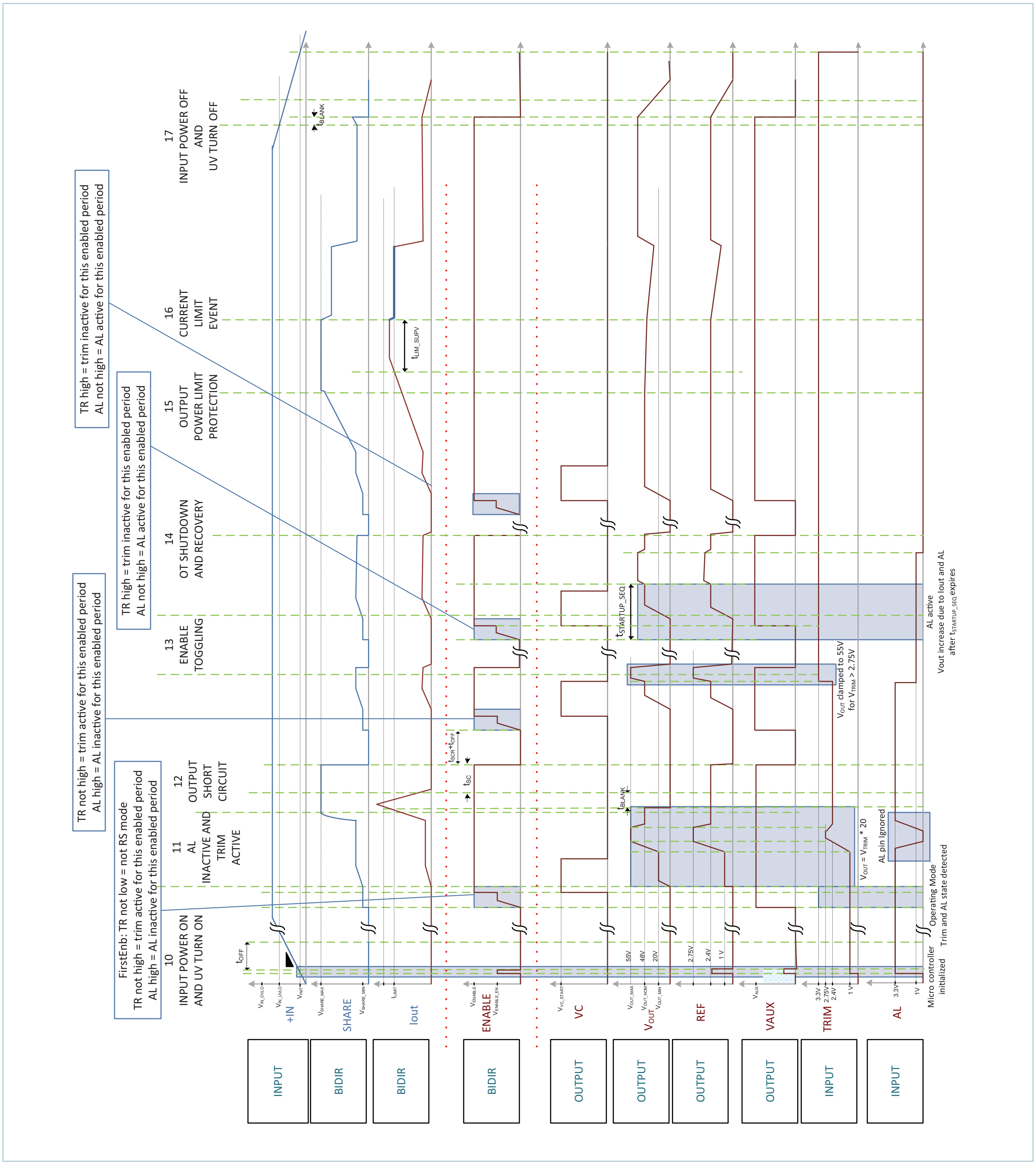
Timing Diagrams (Adaptive Loop Operation)

Module Inputs are shown in blue; Module Outputs are shown in brown.



Timing Diagrams (Adaptive Loop Operation) (cont.)

Module Inputs are shown in blue; Module Outputs are shown in brown.



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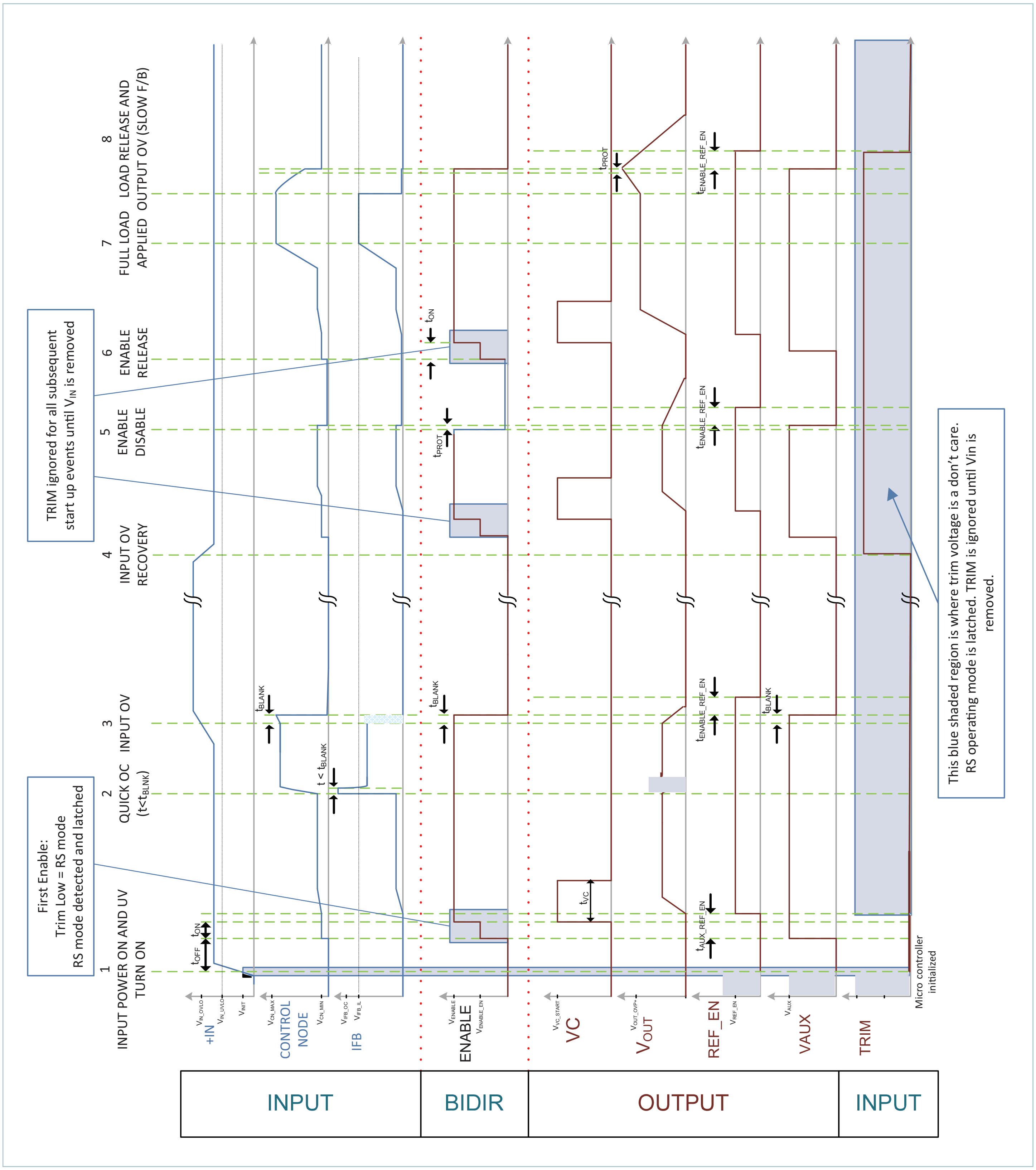
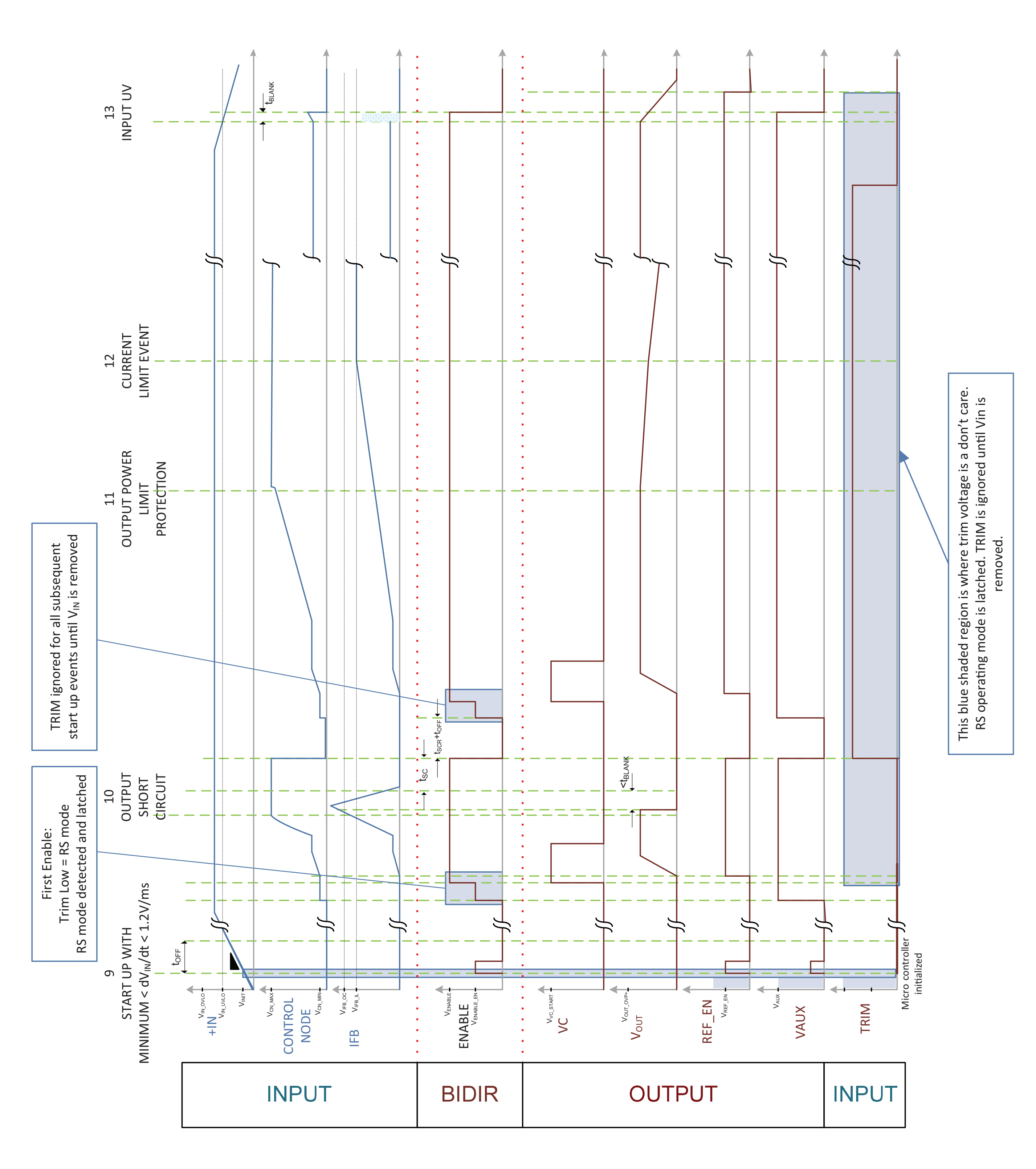
Timing Diagrams (Remote Sense Operation)

Module Inputs are shown in blue; Module Outputs are shown in brown.



Timing Diagrams (Remote Sense Operation) (cont.)

Module Inputs are shown in blue; Module Outputs are shown in brown.



Typical Performance Characteristics

The following figures present typical performance at T_C = 25°C, unless otherwise noted. See associated figures for general trend data.

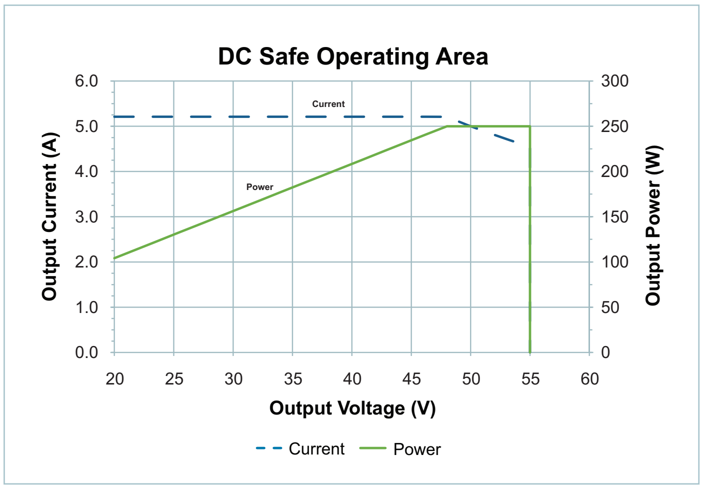


Figure 1 ? !%*) 3)5%7-1+ 5)% !

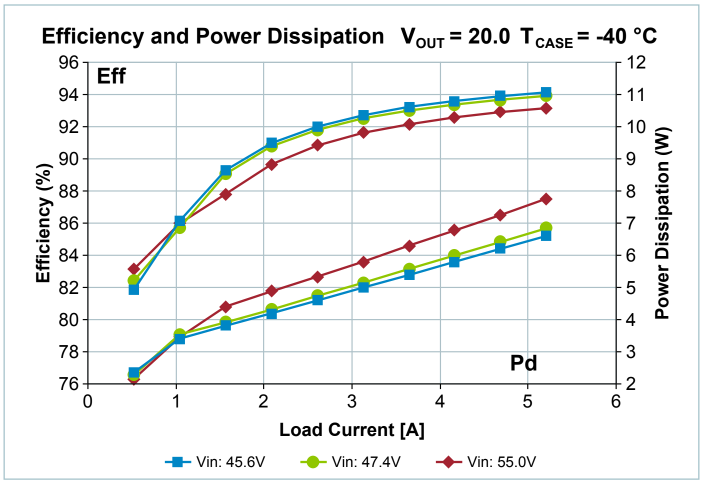


Figure 4 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

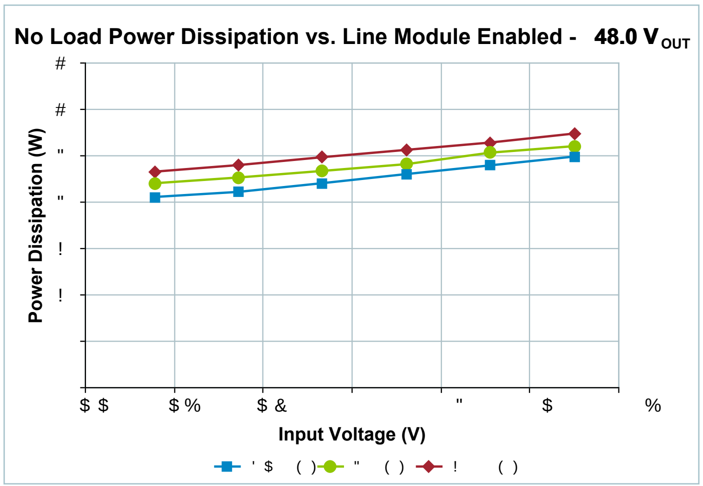


Figure 2 ? 2 2%(2 :)5 -66-3%7-21 96 $ 02(8/))1%&/)(

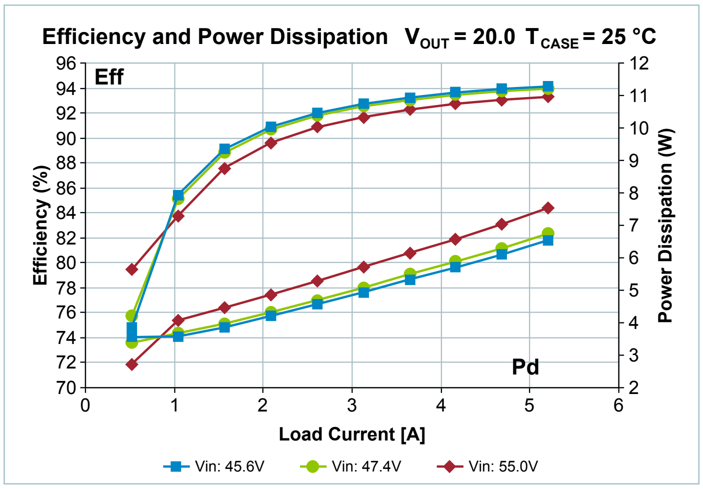


Figure 5 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

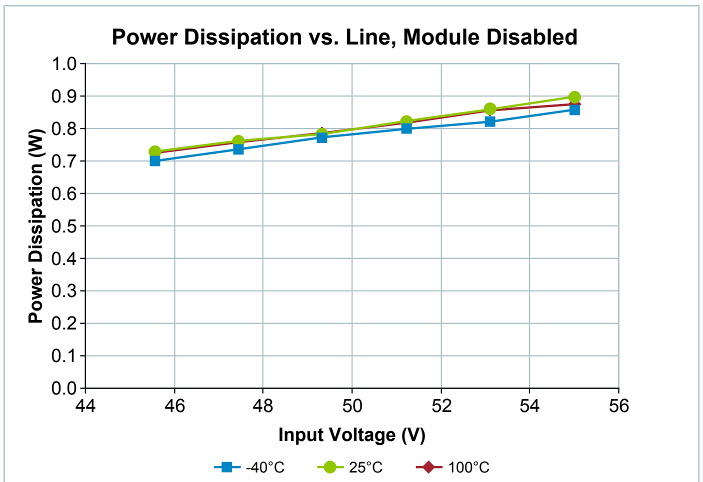


Figure 3 ? 2 2%(2 :)5 -66-3%7-21 96 $ 02(8/) (-6%&/)(1%&/) 2 :

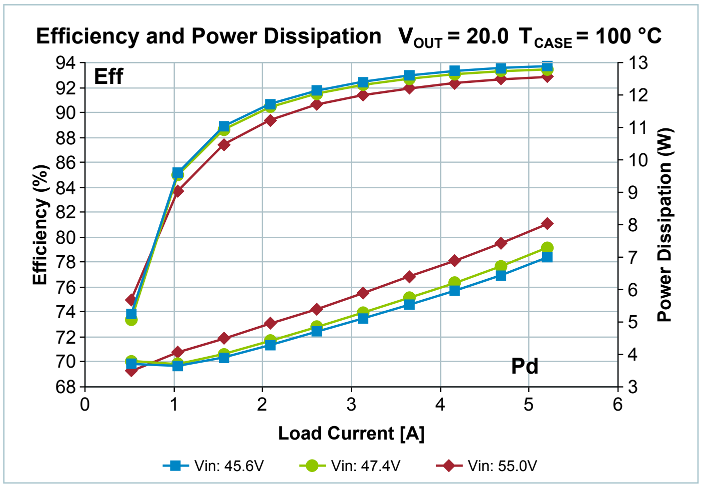


Figure 6 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

Typical Performance Characteristics (cont.)

The following figures present typical performance at T_C = 25°C, unless otherwise noted. See associated figures for general trend data.

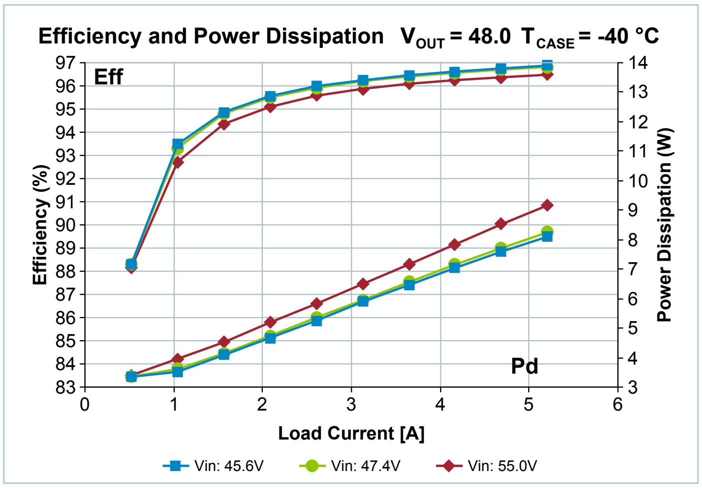


Figure 7 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

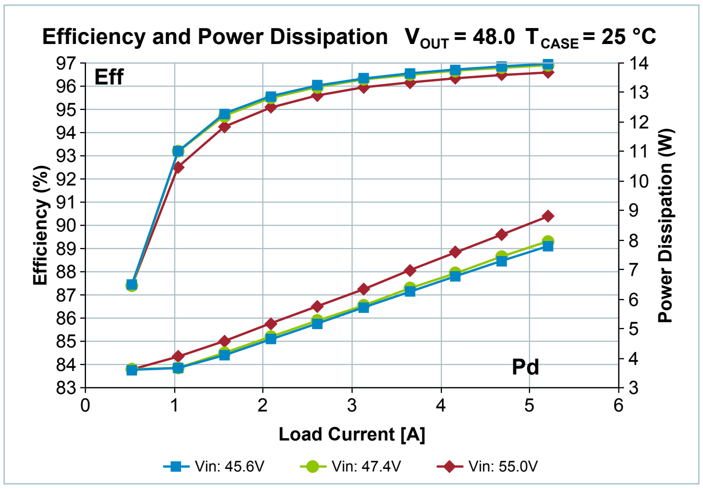


Figure 8 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

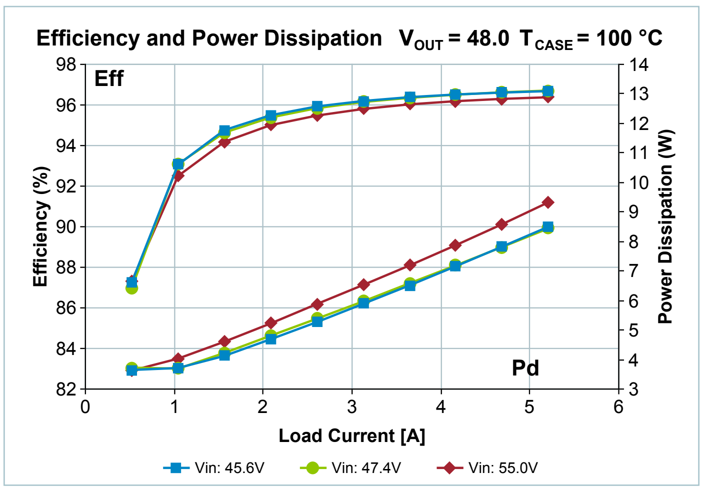


Figure 9 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

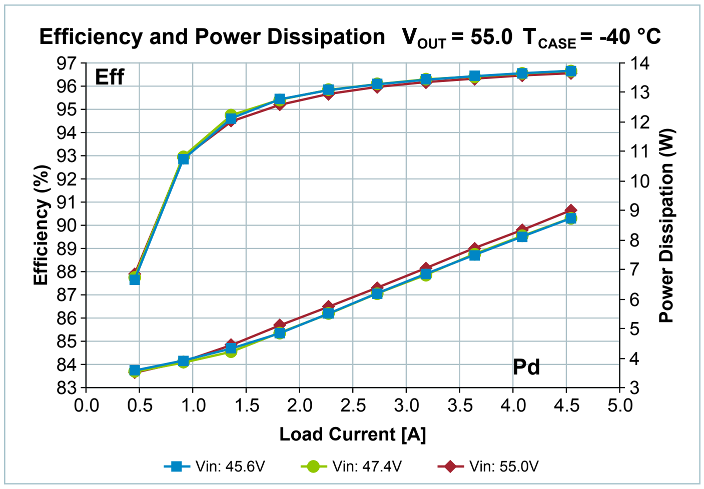


Figure 10 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

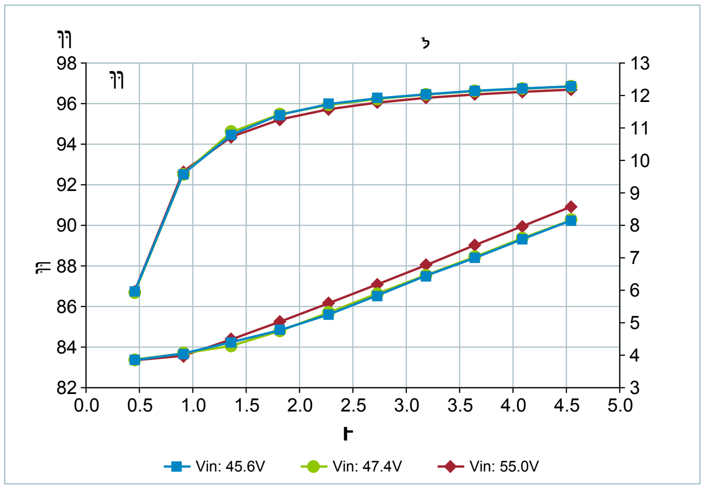


Figure 11 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

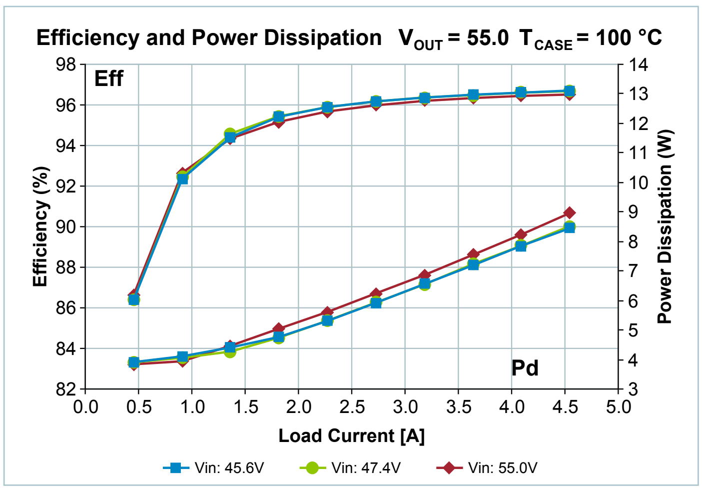


Figure 12 ? "27%/)**-'-)1'< %1(32 :)5 (-66-3%7-21 96 $ %1(#" $ #" $ " ! =

Typical Performance Characteristics (cont.)

The following figures present typical performance at T_C = 25°C, unless otherwise noted. See associated figures for general trend data.

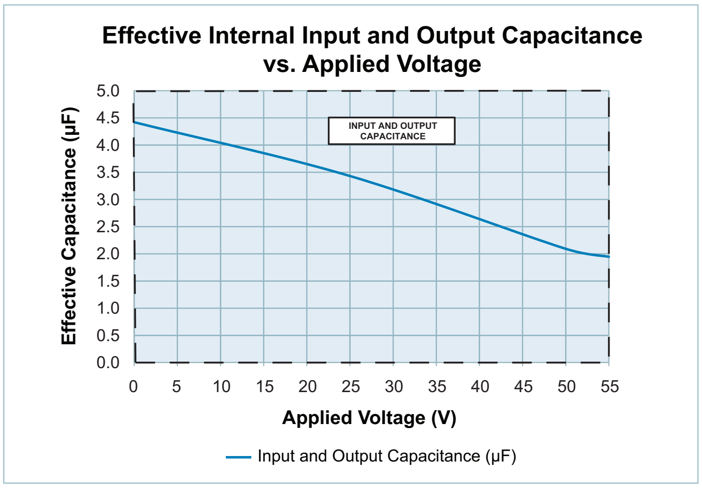


Figure 13 ? **)'7-9) 17)51%/ 1387 %1(87387 %3%'-7%1') 96 $2/7%+) >)5%0-' "<3)

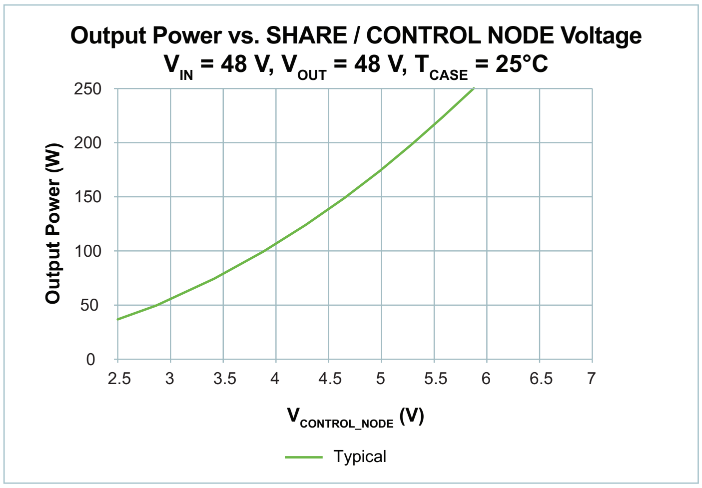


Figure 16 ? 87387 2 :)5 96 ! " $2/7%+) $ $ $ #" $ " ! =

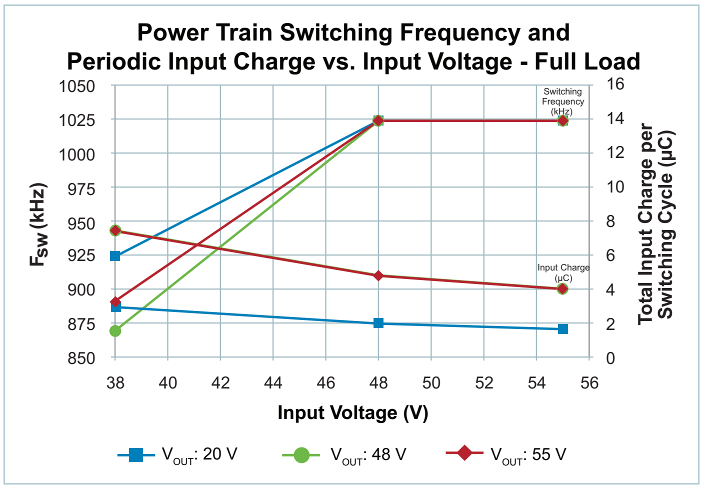


Figure 14 ? "<3-'%/ 2 :)5 "5%-1 ! : -7' , -1+ 5)48)1'< %1( )5-2(-' 1387 , %5+) 96 $ $ #" #"

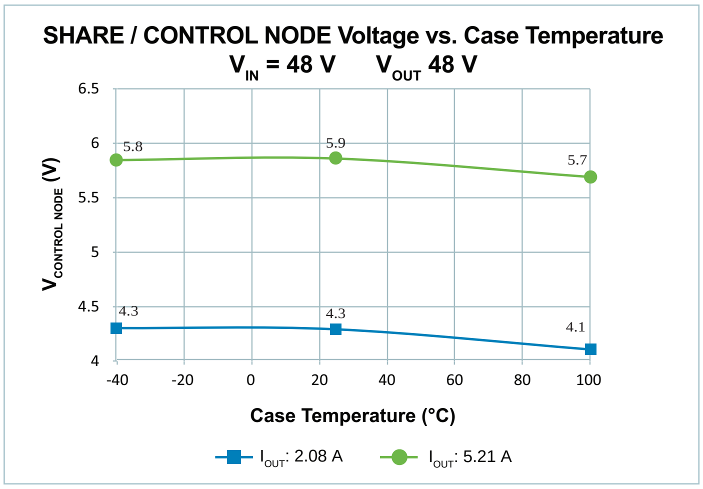


Figure 17 ? "<3-'%/ ! " $2/7%+) 96 " ! %1(#" $ $ $ #" $

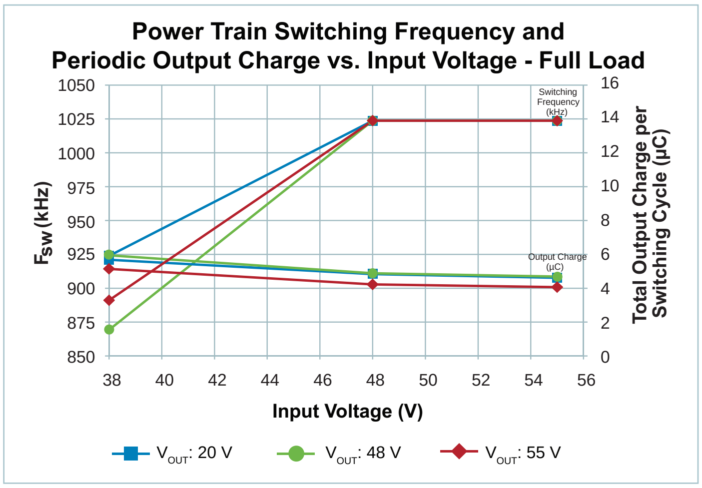


Figure 15 ? "<3-'%/ 2 :)5 "5%-1 ! : -7' , -1+ 5)48)1'< %1( )5-2(-' 87387 , %5+) 96 $ $ #" #"

Typical Performance Characteristics (cont.)

The following figures present typical performance at $T_C = 25°C$, unless otherwise noted. See associated figures for general trend data.

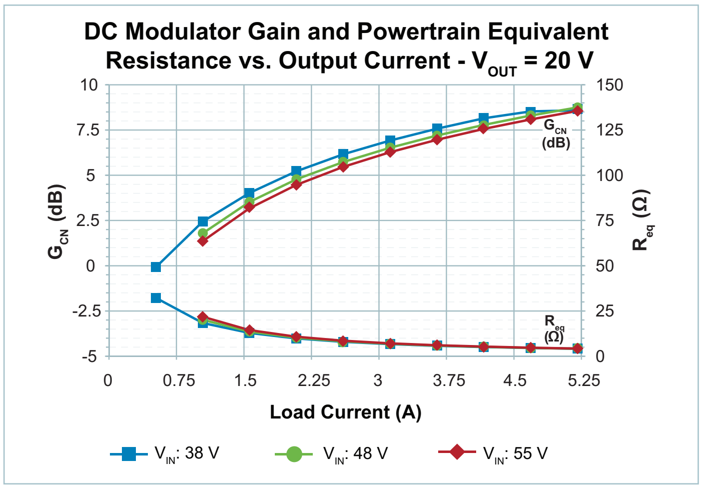


Figure 18 ? 2 :)575%-1 ,%5%'7)5-67-'6 96 #" $)6-67-9) 2%($ #" $

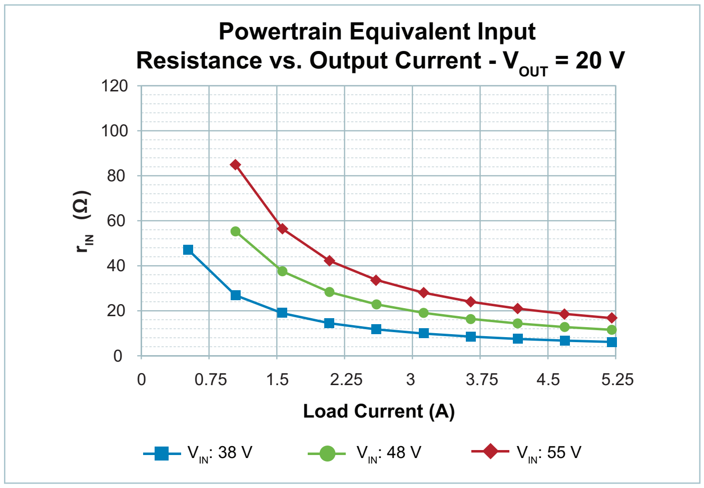


Figure 21 ? %+1-78( ) 2* 32 :)575%-1 (<1%0-' -1387 -03) (%1') 96 #" $ $ #" $

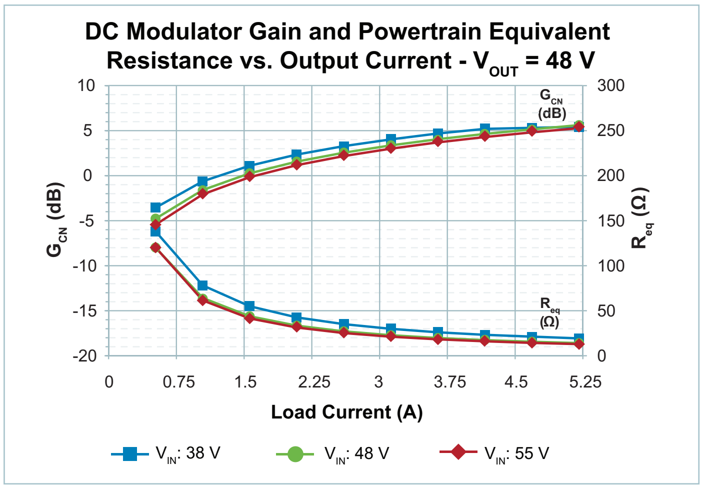


Figure 19 ? 2 :)575%-1 ,%5%'7)5-67-'6 96 #" $)6-67-9) 2%($ #" $

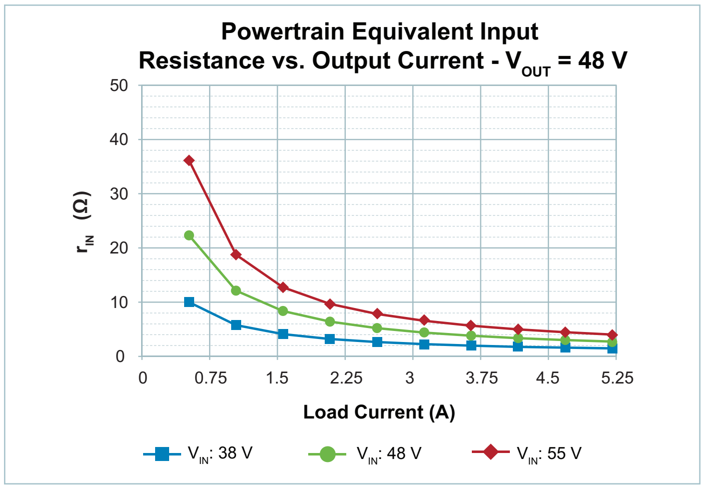


Figure 22 ? %+1-78( ) 2* 32 :)575%-1 (<1%0-' -1387 -03) (%1') 96 #" $ $ #" $

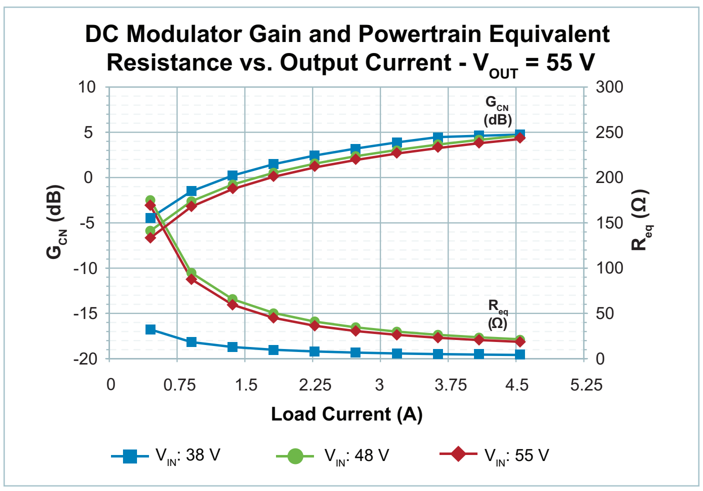


Figure 20 ? 2 :)575%-1 ,%5%'7)5-67-'6 96 #" $)6-67-9) 2%($ #" $

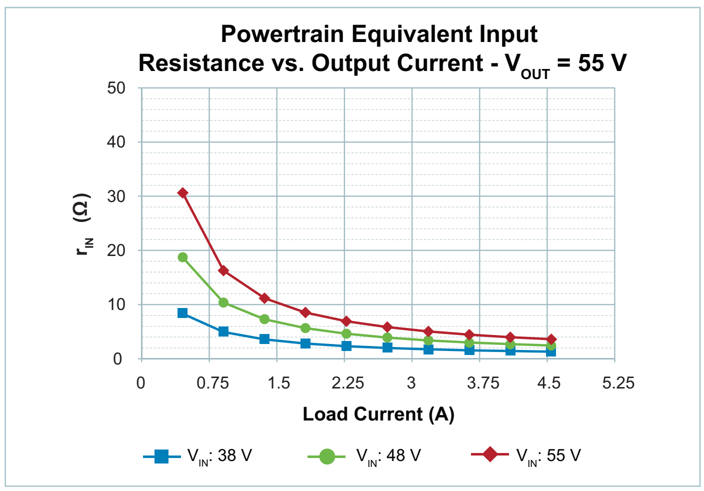


Figure 23 ? %+1-78( ) 2* 32 :)575%-1 (<1%0-' -1387 -03) (%1') 96 #" $ $ #" $

General Characteristics

Specifications apply over all line and load conditions, T_{INT} = 25°C and output voltage from 20.0 V to 55.0 V, unless otherwise noted. **Boldface specifications apply over the temperature range of -40°C < T_{INT} < 125°C (T-grade).**

Attribute	Symbol	Conditions / Notes	Min	Typ	Max	Unit
		Mechanical				
Length	L		**21.8**	**22.0**	**22.3**	mm
			(0.86)	**(0.87)**	**(0.88)**	in
Width	W		**16.3**	**16.5**	**16.8**	mm
			(0.64)	**(0.65)**	**(0.66)**	in
Height	H		**6.48**	**6.73**	**6.98**	mm
			(0.255)	**(0.265)**	**(0.275)**	in
Volume	Vol	No Heatsink		**2.44**		cm^3
				(0.15)		in^3
Weight	W			**7**		g
Lead Finish		Nickel	**0.51**		**2.03**	µm
		Palladium	**0.02**		**0.15**	µm
		Gold	**0.003**		**0.050**	µm
		Thermal				
Operating Internal Temperature	T_{INT}	T Grade	**-40**		**125**	°C
		M Grade	**-55**		**125**	°C
Thermal Impedance	$\theta_{INT\text{-}CASE}$			**2**		°C/W
	$\theta_{INT\text{-}LEAD}$			**9**		°C/W
Thermal Capacity				**5**		Ws / °C
		Assembly				
Peak Compressive Force Applied to Case (Z-axis)		Supported by J-Lead only			**3**	lbs
					5.3	lbs / in^2
Storage Temperature	T_{ST}	T Grade	**-40**		**125**	°C
		M Grade	**-65**		**125**	°C
ESD Rating	HBM	Method per Human Body Model Test ESDA/JEDEC JDS-001-2012	**CLASS 1C**			V
	CDM	Charged Device Model JESD22-C101E	**CLASS 2**			V
		Soldering				
Peak Temperature During Reflow		MSL 4 (Datecode 1528 and later)			**245**	°C
Maximum Time Above 217 °C				**60**	**90**	s
Peak Heating Rate During Reflow				**1.5**	**2.0**	°C / s
Peak Cooling Rate Post Reflow				**2.5**	**3.0**	°C / s
		Reliability and General Agency Approvals				
MTBF		Telcordia Issue 2 - Method I Case 1; Ground Benign, Controlled		**5.28**		MHrs
		MIL-HDBK-217 Plus Parts Count - 25C Ground Benign, Stationary, Indoors / Computer Profile		**5.29**		MHrs
Agency Approvals / Standards		$_{C}$TUV$_{US}$				
		CE Marked for Low Voltage Directive and RoHS Recast Directive, as applicable				

Pin Functions

+IN, -IN
@BGF BA I 7D B;@E

+OUT, -OUT
&GFBGF BA I 7D B;@E $ A6G>7 53@@AF E;@= 5GDD7@F

ENABLE
+ : ;E B;@ FGD@E F : 7 EGBB>K A@ 3@6 A88 + : 7 B;@ ;E 4AF : 3@ ;@BGF 3@6 3@ AGFBGF 3@6 53@ BDAH;67 F : 7 8A>>A I ;@9 873FGD7E

- 7>3K76 *F3DF GBA@ 3BB>;53F;A@ A8 HA>F397 , - #& FA F : 7 ? A6G>7 BA I 7D ;@BGF 3@6 38F7D FA88 F : 7 % # B;@ I ;>> EAGD57 3 5A@EF3@F ' 5GDD7@F
- &GFBGF 7@34>7 . : 7@ % # ;E 3>>A I 76 FA BG>> GB 34AH7 F : 7 7@34>7 F : D7E : A>6 F : 7 % # B;@ I ;>> BG>> GB FA - I ;F : ? EAGD57 53B34;>;FK 3@6 F : 7 ? A6G>7 I ;>> 47 7@34>76
- &GFBGF 6;E34>7 % # ? 3K 47 BG>>76 6A I @ 7JF7D@3>>K ;@ AD67D FA 6;E34>7 F : 7 ? A6G>7 ' G>> 6A I @ D7E;EF3@57 E : AG>6 47 >7EE F : 3@ ^ FA * %
- 3G>F 67F75F;A@ 8>39 + : 7 % # - HA>F397 EAGD57 ;E ;@F7D@3>>K FGD@76 A88 I : 7@ 3 83G>F 5A@6;F;A@ ;E 67F75F76

% # 5A@FDA> E : AG>6 47 ; ? B>7 ? 7@F76 GE;@9 3@ AB7@ 5A>>75FAD 5A@8;9GD3F;A@ F ;E @AF D75A ? ? 7@676 FA 6D;H7 F : ;E B;@ 7JF7D@3>>K

VAUX: Auxiliary Voltage Source
, E7 F : ;E B;@ FA BA I 7D 7JF7D@3> 67H;57E I ;F : 3 @A@ ;EA>3F76 - EGBB>K I ;F : GB FA ? >A36 53B34;>;FK E I ;F5 : 76 I ;F : % # ;@BGF A @AF B>357 3 53B35;FAD AH7D _ A@ F : ;E B;@

SGND: Signal Ground
+ : ;E ;E 3 >A I 5GDD7@F B;@ I : ;5 : BDAH;67E 3 "7>H;@ 5A@@75F;A@ FA F : 7 ') $ E ;@F7D@3> E;9@3> 9DAG@6 , E7 F : ;E B;@ 3E F : 7 9DAG@6 D787D7@57 8AD 7JF7D@3> 5;D5G;FDK 3@6 E;9@3>E FA 3HA;6 HA>F397 6DABE 53GE76 4K : ;9 : 5GDD7@FE A@ BA I 7D D7FGD@E @ 3DD3K 5A@8;9GD3F;A@E * % B;@E E : AG>6 47 EF3D 5A@@75F76 3F 3 E;@9>7 BA;@F E7D;7E D7E;EFAD M ^ FA F : 7 EF3D >A53F;A@ ;E D75A ? ? 7@676 FA 675AGB>7 D7FGD@ 5GDD7@FE

VC: VTM Control
+ : ;E AGFBGF B;@ ;E GE76 FA F7 ? BAD3D;>K BDAH;67 - HA>F397 FA 5A@@75F76 - + $ E 6GD;@9 EF3DF GB + : 7 BG>E7 ;E @A ? ;@3>>K - ? E I ;67 - + $ 53@ E7>8 BA I 7D A@57 ;FE ;@BGF HA>F397 D735 : 7E ;FE ? ;@; ? G ? EB75;8;76 ;@BGF HA>F397 + : 7 ') $ AGFBGF ? GEF 47 5 : 75=76 FA ? 3=7 EGD7 ;F D735 : 7E F : ;E F : D7E : A>6 HA>F397 478AD7 F : 7 - BG>E7 7JB;D7E

TRIM
+ : 7 +) $ B;@ ;E GE76 FA E7>75F F : 7 AB7D3F;@9 ? A67 3@6 FA FD; ? F : 7 ') $ AGFBGF I : 7@ 63BF;H7 #AAB AB7D3F;@9 ? A67 ;E E7>75F76 + : 7 +) $ B;@ : 3E 3@ ;@F7D@3> BG>> GB FA - 2 %+ F : DAG9 : 3 =^ D7E;EFAD

Operating Mode Select:
8 +) $;E BG>>76 47>A I - 6GD;@9 F : 7 8;DEF EF3DFGB 38F7D - % ;E 3BB>;76) 7 ? AF7 *7@E7 *>3H7 AB7D3F;A@ ;E E7>75F76 &F : 7D I ;E7 63BF;H7 #AAB AB7D3F;A@ ;E E7>75F76 + : ;E E7>75F;A@ B7DE;EFE G@F;> - % ;E D7 ? AH76 8DA ? F : 7 B3DF 3@6 ;E @AF 5 : 3@976 4K 83G>F AD 6;E34>7 7H7@FE

Output Voltage Trim:
*7FE F : 7 AGFBGF HA>F397 A8 F : 7 ') $;@ 63BF;H7 #AAB AB7D3F;A@

8 +) $;E B7D ? ;FF76 FA BG>> GB FA - AD : ;9 : 7D 6GD;@9 EF3DF GB FD; ? ;E 6;E34>76 3@6 F : 7 AGFBGF ;E E7F FA F : 7 @A ? ;@3> A8 -

8 +) $;E : 7>6 47F I 77@ - FA - 6GD;@9 EF3DF GB FD; ? ;E 7@34>76 3@6 F : 7 AGFBGF ;E E53>76 4K 3 835FAD A8 D7EG>F;@9 ;@ 3@ AGFBGF HA>F397 D3@97 A8 - FA -

+ : ;E E7>75F;A@ B7DE;EFE G@F;> F : 7 ') $;E D7EF3DF76 I ;F : F : 7 % # B;@ AD 6G7 FA 83G>F 3GFA D75AH7DK

AL: Adaptive Loop (Adaptive Loop Operation)
+ : ;E ;@BGF B;@ 3>>A I E KAG FA E7F F : 7 63BF;H7 #AAB >A36 >;@7 H7DK HA>F A@ F : ;E B;@ D7BD7E7@FE ^ A8 BAE;F;H7 AGFBGF E>AB7 + : 7D ;E 3@ ;@F7D@3> =^ BG>>GB D7E;EFAD FA - 2 %+ 8 # ;E B7D ? ;FF76 FA BG>> GB FA - AD : ;9 : 7D 6GD;@9 EF3DF GB F : 7 63BF;H7 #AAB >A36 >;@7 ;E 6;E34>76

+ : ;E E7>75F;A@ B7DE;EFE G@F;> F : 7 ') $;E D7EF3DF76 I ;F : F : 7 % # B;@ AD 6G7 FA 83G>F 3GFA D75AH7DK

VT: VTM Temperature (Adaptive Loop Operation)
+ : ;E B;@ ;E GE76 ;@ F : 7 63BF;H7 #AAB 5A ? B7@E3F;A@ 3>9AD;F : ? FA 355AG@F 8AD F : 7 - + $ AGFBGF D7E;EF3@57 H3D;3F;A@ 3E 3 8G@5F;A@ A8 F7 ? B7D3FGD7 + : 7 - + $ + $ B;@ BDAH;67E F : ;E HA>F397 E53>76 3E F : 7 F7 ? B7D3FGD7 ;@ " "7>H;@ 6;H;676 4K EA a ;E - #73H7 6;E5A@@75F76 AD BG>> 47>A I - FA 6;E34>7 + : 7 36<GEF ? 7@F ;E 8;J76 3F a D7>3F;H7 FA F : 7 H3>G7 3F a

REF: Reference (Adaptive Loop Operation)
+ : ;E AGFBGF B;@ 3>>A I E KAG FA ? A@;FAD F : 7 ;@F7D@3> D787D7@57 HA>F397 ;@ 63BF;H7 #AAB &B7D3F;A@ GD;@9 @AD ? 3> AB7D3F;A@ ;F D7BD7E7@FE F : 7 AGFBGF HA>F397 E53>76 4K 3 835FAD A8

@ 63BF;H7 #AAB &B7D3F;A@ F : ;E B;@ ;E 8AD ? A@;FAD;@9 BGDBAE7E A@>K 3@6 E : AG>6 @AF 47 6D;H7@ AD >A3676 7JF7D@3>>K

REF_EN: Reference Enable (Remote Sense Operation)
@) 7 ? AF7 *7@E7 &B7D3F;A@ F : ;E B;@ AGFBGFE 3 D79G>3F76 - ? HA>F397 EAGD57 F ;E 7@34>76 A@>K 38F7D EG557EE8G> EF3DF GB A8 F : 7 ') $ BA I 7DFD3;@) 2 % ;E ;@F7@676 FA BA I 7D F : 7 AGFBGF 5GDD7@F FD3@E6G57D 3@6 3>EA F : 7 HA>F397 D787D7@57 8AD F : 7 7JF7D@3> 5A@FDA> >AAB ' A I 7D;@9 F : 7 D787D7@57 97@7D3FAD I ;F :) 2 % : 7>BE BDAH;67 3 5A@FDA>>76 EF3DF GB E;@57 F : 7 AGFBGF HA>F397 A8 F : 7 EKEF7 ? ;E 34>7 FA FD35= F : 7 D787D7@57 >7H7> 3E ;F 5A ? 7E GB

SHARE (Adaptive Loop and Slave Operation)
+ : ;E 4GE E7FE F : 7 AGFBGF 5GDD7@F >7H7> 8AD 3>> F : 7 ') $? A6G>7E I : 7@ AB7D3F;@9 ;@ 3@ 3DD3K ? 3EF7D E>3H7 5A@8;9GD3F;A@ A@@75F F : 7 ? FA97F : 7D 3 ? A@9 F : 7 ? A6G>7E ;@ F : 7 E : 3D76 4GE &@7 ') $ E : AG>6 47 5A@8;9GD76 3E 3 ? 3EF7D 4K 5A@@75F;@9 +) $ 8AD 63BF;H7 #AAB &B7D3F;A@ >> AF : 7D ') $ E E : AG>6 47 5A@8;9GD76 3E E>3H7E 4K BG>>;@9 F : 7;D D7EB75F;H7 +) $ B;@E >A I + : ;E B;@ 53@ 47 GE76 FA ? A@;FAD F : 7 7DDAD HA>F397 7JF7D@3>>K FA >A36 ;E D7BD7E7@F76 4K 3 HA>F397 47F I 77@ - 3@6 -

CONTROL NODE (Remote Sense Operation)
@) 7 ? AF7 *7@E7 &B7D3F;A@ F : ;E ;E F : 7 ;@BGF FA F : 7 ? A6G>3FAD I : ;5 : 67F7D ? ;@7E F : 7 BA I 7DFD3;@ F; ? ;@9 3@6 G>F; ? 3F7>K F : 7 ? A6G>7 AGFBGF BA I 7D @ ;@F7D@3> ? 5GDD7@F E;@= ;E 3> I 3KE 35F;H7 + : 7 4; 6;D75F;A@3> 4G887D 47F I 77@ &%+) &# %& 3@6 F : 7 ? A6G>3FAD : 3E F I A EF3F7E @ @AD ? 3> AB7D3F;A@ &%+) &# %& I ;>> 47 34AH7 F : 7 - E I ;F5 : ;@9 F : D7E : A>6 3@6 I ;>> 6D;H7 F : 7 ? A6G>3FAD F : DAG9 : F : 7 4G887D @ ;@F7D@3> - 5>3 ? B 67F7D ? ;@7E F : 7 ? 3J; ? G ? AGFBGF BA I 7D F : 3F 53@ 47 D7CG7EF76 A8 F : 7 ? A6G>3FAD

. :7@ &%+) &# %& 83>>E 47>A I - F:7 5A@H7DF7D I ;>> EFAB E I ;F5 :;@9 @ ;@F7D@3> 5;D5G;F 5>3 ? BE F:7 ? A6G>3FAD ;@BGF FA - 3@6 3 4G887D I ;>> EAGD57 GB FA ? AGF A8 F:7 B;@ 3F F:3F 5>3 ? B >7H7> AD F:;E D73EA@ F:7 AGFBGF ; ? B763@57 A8 F:7 3 ? B>;8;7D 6D;H;@9 &%+) &# %& ? GEF 47 F3=7@ ;@FA 355AG@F D3;> FA D3;> AB7D3F;A@3> 3 ? B>;8;7D I ;F: >A I AGFBGF ; ? B763@57 ;E 3> I 3KE D75A ? ? 7@676

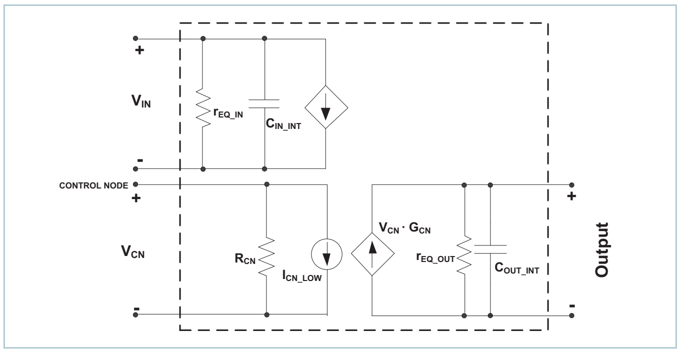


Figure 24 ? x 60%// 6-+1%/ 02()/

+:7 BA I 7DFD3;@ E ? 3>> E;9@3> B>3@F D7EBA@E7 5A@E;EFE A8 3 E;@9>7 BA>7 67F7D ? ;@76 4K F:7 >A36 D7E;EF3@57 F:7 BA I 7DFD3;@ 7CG;H3>7@F AGFBGF D7E;EF3@57 3@6 F:7 FAF3> AGFBGF 53B35;F3@57 ;@F7D@3> 3@6 7JF7D@3> FA F:7 ? A6G>7 AF: F:7 ? A6G>3FAD 93;@ 3@6 F:7 7CG;H3>7@F AGFBGF D7E;EF3@57 H3DK 3E 3 8G@5F;A@ A8 >;@7 >A36 3@6 AGFBGF HA>F397 E F:7 >A36 ;@5D73E7E F:7 BA I 7DFD3;@ BA>7 ? AH7E FA :;9:7D 8D7CG7@5K E 3 D7EG>F F:7 5>AE76 >AAB 5DAEEAH7D 8D7CG7@5K I ;>> 47 F:7 :;9:7EF 3F 8G>> >A36 3@6 >A I 7EF 3F ? ;@; ? G ? >A36 ;9GD7 E:A I E 3 D787D7@57 E ? 3>> E;9@3> ? A67>

IFB: Current Feedback (Remote Sense Operation)

@)7 ? AF7 *7@E7 &B7D3F;A@ ;E F:7 ;@BGF 8AD F:7 ? A6G>7 AGFBGF AH7D5GDD7@F BDAF75F;A@ 3@6 5GDD7@F >; ? ;F 873FGD7E HA>F397 BDABADF;A@3> FA F:7 BA I 7DFD3;@ AGFBGF 5GDD7@F ? GEF 47 3BB>;76 FA ;@ AD67D 8AD AH7D5GDD7@F BDAF75F;A@ FA AB7D3F7 BDAB7D>K 8 F:7 HA>F397 7J5776E F:7 B;@ AH7D5GDD7@F BDAF75F;A@ F:D7E:A>6 F:7 BA I 7DFD3;@ I ;>> EFAB E I ;F5 :;@9 8 F:7 HA>F397 83>>E 47>A I F:7 AH7D5GDD7@F BDAF75F;A@ F:D7E:A>6 I ;F:;@ F # %" F; ? 7 F:7@ F:7 BA I 7DFD3;@ I ;>> ; ? ? 76;3F7>K D7EG ? 7 E I ;F5 :;@9 &F:7D I ;E7 3 83G>F ;E 67F75F76

+:7 5GDD7@F >; ? ;F F:D7E:A>6 8AD F:7 B;@ ;E E7F >A I 7D F:3@ F:7 BDAF75F;A@ F:D7E:A>6 . :7@ F:7 B;@ 3H7D397 HA>F397 7J5776E F:7 5GDD7@F >; ? ;F F:D7E:A>6 3@ ;@F7D@3> ;@F79D3FAD I ;>> 35F;H3F7 3 5>3 ? B 3 ? B>;8;7D I :;5: AH7DD;67E F:7 ? A6G>3FAD ;@BGF ? 3J; ? G ? >7H7> +:;E 53GE7E F:7 BA I 7DFD3;@ FA ? 3;@F3;@ 3 5A@EF3@F AGFBGF 5GDD7@F +:7 43@6 I ;6F: A8 F:;E 5GDD7@F >; ? ;F ;@F79D3FAD ;E E;9@;8;53@F>K EA I 7D F:3@ F:3F A8 F:7 &%+) &# %& ;@BGF +:7D78AD7 F:;E 5GDD7@F >; ? ;F 53@@AF 47 GE76 ;@ >;7G A8 BDAB7D>K 5A ? B7@E3F;@9 F:7 7JF7D@3> 5A@FDA> >AAB FA 3HA;6 7J5776;@9 ? 3J; ? G ? 5GDD7@F AD BA I 7D D3F;@9E 8AD F:7 67H;57

Design Guidelines

+:7 ')$! x D79G>3FAD ;E EB75;8;53>>K 67E;9@76 FA BDAH;67 3 5A@FDA>>76 35FAD;L76 GE 6;EFD;4GF;A@ HA>F397 8AD BA I 7D;@9 6A I @EFD73 ? -+$ +D3@E8AD ? 7D V 83EF 788;5;7@F ;EA>3F76 >A I @A;E7 'A;@F A8 #A36 '&# 5A@H7DF7DE

+:7 ')$! x 53@ 47 5A@8;9GD76 8AD F I A AB7D3F;@9 ? A67E 67B7@6;@9 A@ F:7 FKB7 A8 D79G>3F;A@ D7CG;D76

@ 63BF;H7 #AAB &B7D3F;A@ F:7 D79G>3F;A@ 5;D5G;FDK ;E 7@34>76 I ;F:;@ F:7 67H;57 3@6 D79G>3F7E F:7 HA>F397 3F F:7 AGFBGF F7D ? ;@3>E +:7 ')$! x :3E 3 BDA9D3 ? ? 34>7 63BF;H7 #AAB >A36 >;@7 I :;5: 53@ 47 GE76 FA 5A ? B7@E3F7 8AD 6A I @EFD73 ? -+$ AGFBGF D7E;EF3@57 3>>A I ;@9 8AD BD75;E7 BA;@F A8 >A36 D79G>3F;A@ I ;F:AGF F:7 @776 8AD D7 ? AF7 E7@E;@9

@)7 ? AF7 *7@E7 &B7D3F;A@ F:7 ;@F7D@3> D79G>3F;A@ 5;D5G;FDK ;E 6;E34>76 3@6 F:7 HA>F397 D79G>3F;A@ 5;D5G;FDK ;E BDAH;676 7JF7D@3>>K 3>>A I ;@9 8AD D7 ? AF7 E7@E;@9 6;D75F>K 3F F:7 BA;@F A8 >A36 @ 57DF3;@ 3BB>;53F;A@E)7 ? AF7 *7@E7 &B7D3F;A@ 53@ ; ? BDAH7 D79G>3F;A@ 355GD35K 3@6 3>>A I 8AD AB7D3F;@9 I ;F: :;9: 3 ? AG@FE A8 >A36 53B35;F3@57 3@6 ABF; ? ;L;@9 >A36 FD3@E;7@F D7EBA@E7

Operating Mode Selection

+:7 AB7D3F;@9 ? A67 ;E E7>75F76 F:DAG9: GE7 A8 F:7 +)$ B;@ . :7@ F:7 B3DF ;E 8;DEF 7@34>76 38F7D - % ;E 3BB>;76 F:7 +)$ HA>F397 ;E E3 ? B>76 +:7 +)$ B;@ :3E 3@ ;@F7D@3> BG>> GB D7E;EFAD FA - 2 %+ EA G@>7EE 7JF7D@3> 5;D5G;FDK BG>>E F:7 B;@ HA>F397 >A I 7D ;F I ;>> 8>A3F GB FA - 2 %+

8 +)$;E BG>>76 >A I 7D F:3@ - 6GD;@9 F:7 8;DEF EF3DFGB 38F7D - % ;E 3BB>;76 F:7 B3DF I ;>> 47 5A@8;9GD76 8AD)7 ? AF7 *7@E7 *>3H7 &B7D3F;A@ I :7D7 F:7 ;@F7D@3> HA>F397 D79G>3F;A@ 5;D5G;FDK ;E 6;E34>76 @ F:;E 53E7 8AD 3>> EG4E7CG7@F AB7D3F;A@ F:7 B3DF I ;>> AGFBGF 3 HA>F397 67B7@67@F A@ F:7 *) &%+) &# %& HA>F397 BDAH;676 7JF7D@3>>K 7;F:7D 8DA ? 3@ 7JF7D@3> D79G>3F;A@ 5;D5G;F AD ? 3EF7D ')$

+A 5A@8;9GD7 F:7 B3DF 8AD)7 ? AF7 *7@E7 AD *>3H7 &B7D3F;A@ 5A@@75F F:7 +)$ B;@ FA * % F;E D75A ? ? 7@676 FA ? 3=7 F:;E 5A@@75F;A@ F:DAG9: 3 ^ <G ? B7D 8AD FDAG4>7E:AAF;@9 BGDBAE7E

8 F:7 E3 ? B>76 +)$ HA>F397 ;E :;9:7D F:3@ - 6GD;@9 F:7 8;DEF EF3DFGB 38F7D - % ;E 3BB>;76 F:7@ F:7 B3DF I ;>> 47 5A@8;9GD76 8AD 63BF;H7 #AAB &B7D3F;A@ 3@6 F:7 ;@F7D@3> HA>F397 D79G>3F;A@ 5;D5G;FDK ;E 7@34>76 +:7 ')$ I ;>> AGFBGF 3 HA>F397 67B7@67@F A@ F:7 +)$ HA>F397 3@6 I ;>> D7 ? 3;@ ;@ F:;E ? A67 8AD 3E >A@9 3E - % ;E 3BB>;76

+A 5A@8;9GD7 F:7 B3DF 8AD 63BF;H7 #AAB &B7D3F;A@ >73H7 F:7 +)$ B;@ 6;E5A@@75F76 AD 3BB>K 3 HA>F397 D7E;EF3@57 I ;F:;@ F:7 EB75;8;76 D3@97

+:7 AB7D3F;@9 ? A67 ;E 67F75F76 3@6 67F75F76 6GD;@9 F:7 8;DEF EF3DF GB 38F7D - % ;E 3BB>;76 +:;E E7>75F;A@ B7DE;EFE G@F;> - % ;E D7 ? AH76 8DA ? F:7 B3DF 3@6 ;E @AF 5:3@976 4K 83G>F AD 6;E34>7 7H7@FE :3@9;@9 F:7 AB7D3F;@9 ? A67 53@ A@>K 47 6A@7 4K D7 ? AH;@9 - %

Design Guidelines (Adaptive Loop Operation)

@ 63BF;H7 #AAB &B7D3F;A@ F:7 ;@F7D@3> HA>F397 5A@FDA> 5;D5G;FDK ;E 7@34>76 3@6 F:7 HA>F397 3F F:7 AGFBGF F7D?;@3>E ;E D79G>3F76 +:7 B3DF ;E @A?;@3>>K E7F FA BDAH;67 3 8;J76 - AGFBGF 3@6 F:7 +) $ B;@ 53@ 47 GE76 FA 36<GEF F:7 AGFBGF AH7D F:7 D3@97 A8 - FA -

. :7@ GE76 I ;F: 3 -+$ F:7 # B;@ BDAH;67E 34;>;FK FA BDA9D3? 3@ 63BF;H7 #AAB >A36 >;@7 FA 5A?B7@E3F7 8AD F:7 AGFBGF D7E;EF3@57)&,+ A8 3 6A I @EFD73? -+$ I :;>7 F:7 -+B;@ BDAH;67E F7?B7D3FGD7 5A?B7@E3F;A@ FA 355AG@F 8AD 5:3@97E ;@ F:7 -+$)&,+ AH7D F7?B7D3FGD7

Trim Mode and Output Trim Control (Adaptive Loop Operation)

@ 63BF;H7 #AAB &B7D3F;A@ 6GD;@9 3@K EF3DF GB 3@6 38F7D % # FD3@E;F;A@E :;9: F:7+) $ B;@ HA>F397 ;E E3?B>76 FA 67F7D?;@7 ;8 FD;? ;E 35F;H7 AD ;@35F;H7 8 F:7 E3?B>76 +) $ HA>F397 ;E :;9:7D F:3@ - F:7@ F:7 ') $ I ;>> 6;E34>7 FD;? @ F:;E 53E7 8AD 3>> EG4E7CG7@F AB7D3F;A@ F:7 AGFBGF HA>F397 I ;>> 47 BDA9D3??76 FA F:7 @A?;@3> AGFBGF A8 - 3@6 F:7+) $ B;@ I ;>> 47 ;9@AD76 6GD;@9 @AD?3> AB7D3F;A@

8 F:7 E3?B>76 +) $ HA>F397 ;E 47F I 77@ - 3@6 - F:7@ F:7 ') $ I ;>> 35F;H3F7 FD;? ?A67 3@6 ;F I ;>> D7?3;@ ;@ F:;E ?A67 3E >A@9 3E F:7 ') $;E AB7D3F;@9

+:;E E7>75F;A@ B7DE;EFE G@F;> F:7 ') $;E D7EF3DF76 I ;F: F:7 % # B;@ AD 6G7 FA 83G>F 3GFA D75AH7DK

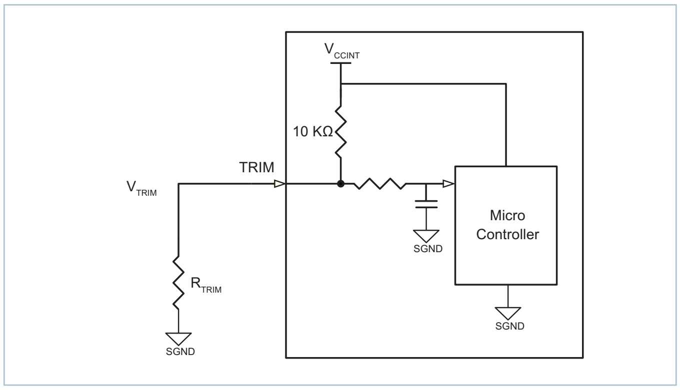


Figure 25 ? " 211)'7-21

+:7 AGFBGF 3E 3 8G@5F;A@ A8 -+) $;E 678;@76 4K 7CG3F;A@ 8AD - ≤ -+) $ \ - 3@6 3>A I E 8AD 3@ AGFBGF HA>F397 D3@9;@9 8DA? - FA -

+:7+) $ B;@ ;E BG>>76 GB ;@F7D@3>>K FA - 2 %+ F:AGAG9: 3 =] D7E;EFAD -+) $ 53@ 47 35F;H7>K E7F I ;F: 3 F:3F ;E 9DAG@6 D787D7@576 FA * % -+) $ 53@ 47 B3EE;H7>K E7F 4K 5A@@75F;@9 3 D7E;EFAD)+) $ 8DA? +) $ FA * % EG5: F:3F F:7 HA>F397 6;H;67D ?367 I ;F: - 2 %+ 3@6 F:7 =] BG>> GB K;7>6E F:7 67E;D76 -+) $ +:7 8AD?G>3 8AD 53>5G>3F;@9 F:;E D7E;EFAD ;E BDAH;676 ;@ CG3F;A@ 3

$$V_{OUT} = V_{TRIM} \bullet 20$$

$$R_{TRIM} = \frac{k\Omega \cdot V_{TRIM}}{V_{CC_{INT}} - V_{TRIM}} = \frac{k\Omega \cdot V_{OUT\_SET}}{\cdot V_{CC_{INT}} - V_{OUT\_SET}} \qquad 3$$

AD -\ -+) $ \ - I :7D7 -&,+2* + ;E F:7 67E;D76 AGFBGF HA>F397

+:7 AGFBGF HA>F397 FD3@87D 8G@5F;A@ E3FGD3F7E 8AD 3BB>;76 +) $ HA>F397E 34AH7 3BBDAJ;?3F7>K - 3E ;>>GEFD3F76 ;@ ;9GD7 FA BD7H7@F F:7 AGFBGF 8DA? 47;@9 6D;H7@ 34AH7 ;FE D3F76 AGFBGF HA>F397

. :7@ +) $;E E7F >A I 7D F:3@ - F:7 AGFBGF HA>F397 ;E @AF EB75;8;76 3@6 EF34>7 AB7D3F;A@ ;E @AF 9G3D3@F776

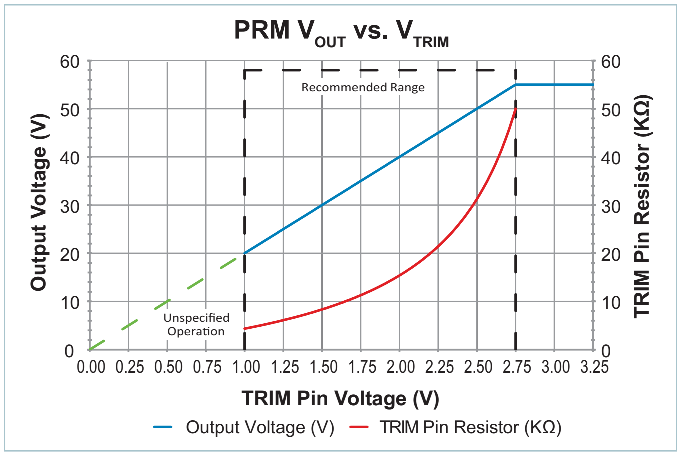


Figure 26 ? $ #" 96 $"

. :7@ FD;? ;E 7@34>76 F:7 HA>F397 3F F:;E B;@ ;E E3?B>76 3F _E ;@F7DH3>E FA 67F7D?;@7 F:7 FD;? >7H7> +:7 AGFBGF 53@ 47 6K@3?;53>>K FD;??76 6GD;@9 @AD?3> AB7D3F;A@ :A I 7H7D ;F ;E @AF D75A??7@676 FA GE7 F:;E B;@ ;@ 3@ 7JF7D@3> 3@3>A9 8776435 >AAB

)787D FA +34>7 8AD 3 EG??3DK A8 F:7 +) $ B;@ 8G@5F;A@3>;FK 3@6 F:7 D75A??7@676 HA>F397 D3@9;@9 F:3F E:AG>6 47 3BB>;76 FA F:;E B;@

Trim Pin Function Summary				
Operating State		**V_{TRIM}**	**R_{TRIM}**	**Detected and Latched**
Remote Sense / Slave Operation		<0.45 V	<1 k	At application of V_{IN} when ENABLE first transitions high
Adaptive Loop Operation		>0.55 V [2]	>3 k [2]	At application of V_{IN} when ENABLE first transitions high
Adaptive Loop Operation Trim Mode	Trim Active $V_{OUT} = 20^{*} V_{TRIM}$	1.00 V to 2.75 V	4.32 k to 49.9 k	At every start up when ENABLE transitions high
	Trim Inactive $V_{OUT} = 48.0$ V	>3.20 V	>10 M	

Table 1 ? " -1 81'7-21 !80 0%5<

[2] It is not recommended to configure TRIM with a voltage less than 1.00 V in Adaptive Loop Operation

Adaptive Loop Compensation (Adaptive Loop Operation)

835FAD;L76 BA I 7D EKEF7 ? @3FGD3>>K :3E 3 >A36 >;@7 3EEA5;3F76 I ;F: ;F E;@57 F:7 D79G>3FAD EF397 ') $;E BAE;F;A@76 478AD7 F:7 ;EA>3F;A@ 3@6 HA>F397 FD3@E8AD ? 3F;A@ EF397 - + $ A@E;67D 8AD 3 ? A ? 7@F 3 835FAD;L76 BA I 7D EKEF7 ? F:3F :3E F:7 8A>>A I ;@9 B3D3 ? 7F7DE

- - -
- " - + $
-) & , +2 - + $? A : ? a

F @A >A36 F:7 AGFBGF HA>F397 3F F:7 >A36 I ;>> 47 7CG3> FA - W " - + $. ;F: ;@5D73E;@9 >A36 5GDD7@F F:7 AGFBGF HA>F397 3F F:7 >A36 I ;>> 6DAB 3F 3 D3F7 BDABADF;A@3> FA F:7 - + $ E) & , + F E:AG>6 47 @AF76 F:3F F:7) & , + :3E 3 BAE;F;H7 F7 ? B7D3FGD7 5A788;5;7@F 3@6 EA F:7 >A36 >;@7 5:3@97E I ;F: F7 ? B7D3FGD7

8 F:7 BD7E7@57 A8 F:;E >A36 >;@7 ;E 3557BF34>7 8AD KAGD 3BB>;53F;A@ F:7@ F:7 ') $ 53@ 47 5A@8;9GD76 4K I 3K A8 F:7 +) $ B;@ 3>A@7 ' >73E7 D787D FA F:7 +D; ? ? ;@9 F:7 &GFBGF - A>F397 E75F;A@ 8AD 67F3;>E @ F:;E 53E7 4AF: F:7 # 3@6 - + B;@E E:AG>6 47 >78F AB7@

8 F:7 BD7E7@57 A8 F:;E >A36 >;@7 ;E G@67E;D34>7 F:7 >A36 >;@7 53@ 47 7>; ? ;@3F76 4K I 3K A8 F:7 ') $ E 63BF;H7 #AAB # 7@9;@7 + :7 # 7@9;@7 ? 73EGD7E F:7 AGFBGF 5GDD7@F A8 F:7 ') $ 3@6 355AD6;@9>K ;@5D73E7E F:7 AGFBGF HA>F397 A8 F:7 ') $;@ AD67D FA D79G>3F7 F:7 ') $ E AGFBGF D7E;EF3@57 FA 3 8;J76 @793F;H7 D7E;EF3@57) ##2 # E7FF34>7 4K I 3K A8 F:7 # B;@) ##2 # E:AG>6 47 E;L76 FA 7J35F>K 53@57> F:7) & , + A8 F:7 - + $ 3F a + :7 # 7@9;@7 ;E 3>EA 34>7 FA 355AG@F 8AD F:7 BAE;F;H7 F7 ? B7D3FGD7 5A788;5;7@F A8) & , + 4K I 3K A8 ;FE - + B;@ I ::;5: I ;>> 47 7JB>3;@76 E:ADF>K

Setting the Adaptive Loop Load Line (Adaptive Loop Operation)

+A 67F7D ? ;@7 3@ 3BBDABD;3F7 H3>G7 8AD F:7 5A ? B7@E3F;A@ E>AB7) ##2 # ;F :7>BE FA D78>75F F:7 - + $ E AGFBGF D7E;EF3@57 FA F:7 ;@BGF E;67 A8 F:7 - + $ D7E;EF3@57 A@ F:7 AGFBGF E;67 A8 F:7 - + $;E E53>76 4K F:7 - + $ E FD3@E8AD ? 7D D3F;A " - + $ ECG3D76 3E E:AI@ 4K 7CG3F;A@

$$R_{LLAL} = R_{OUT\_REFL} = R_{OUT\_VTM\_25C} \bullet \left(\frac{1}{K_{VTM}}\right)^2$$

. :7D7
) & , +2 - + $;E F:7 - + $ AGFBGF D7E;EF3@57 3F a
" - + $;E F:7 - + $ FD3@E8AD ? 7D D3F;A - % - & , +

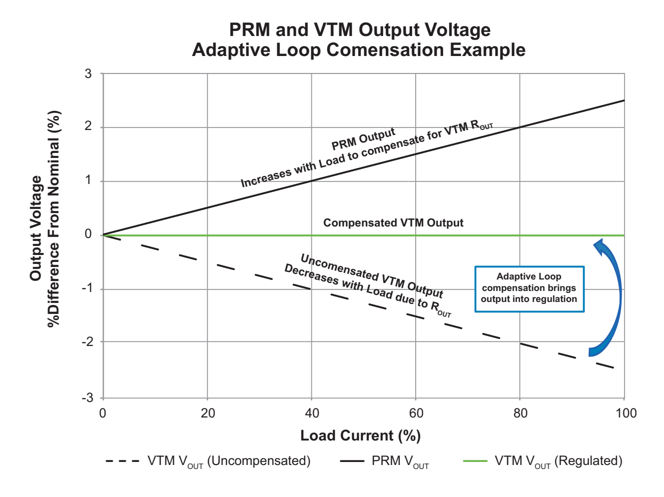


Figure 27 ? (%37-9) 223 2 0 3)16%7-21 //8675%7-21

AD AGD :KBAF:7F;53> - + $ 8DA ? 34AH7 I ;F: " - + $ 3@6) & , +2 - + $?] F:7 AGFBGF D7E;EF3@57 D78>75F76 AH7D FA F:7 ;@BGF I AG>6 47 7CG3> FA ?] AD F:;E 7J3 ? B>7) ##2 # E:AG>6 47 E7F FA ?] FA 3BBDAJ; ? 3F7>K 53@57> 3F a F:7 ;@ :7D7@F >A36 >;@7 8DA ? F:7 - + $

) ##2 # ;E E7F 4K F:7 HA>F397 6;887D7@57 47F I 77@ F:7 # B;@ 3@6 * % B;@ - # B7D F:7 8A>>A I ;@9 8AD ? G>3

$$R_{LL\_AL} = V_{AL} \bullet (-1.0)\ \Omega/V$$

$$V_{AL} \leq 3.10\ V$$

. :7D7 - # ;E F:7 HA>F397 A@ F:7 # B;@

- # ;E E3 ? B>76 4K 3 4;F : AE7 ;@BGF ;E 5A@@75F76 FA - 2 %+ F:DAG9: 3 =] BG>> GB D7E;EFAD + :;E BG>> GB 6;E34>7E F:7 # 7@9;@7 I :7@ F:7 # B;@ ;E >78F AB7@ - # 53@ 47 35F;H7>K E7F I ;F: 3 F:3F ;E 9DAG@6 D787D7@576 FA * % - # 53@ 47 B3EE;H7>K E7F 4K 5A@@75F;@9 3 D7E;EFAD) # 8DA ? # FA * % EG5: F:3F F:7 HA>F397 6;H;67D ? 367 I ;F: - 2 %+ 3@6 F:7 =] BG>> GB K;7>6E F:7 67E;D76 - # + :7 8AD ? G>3 8AD 53>5G>3F;@9 F:;E D7E;EFAD ;E BDAH;676 ;@ CG3F;A@

$$R_{AL} = \frac{10\ k\Omega \cdot V_{AL}}{V_{CC\_INT} - V_{AL}}$$

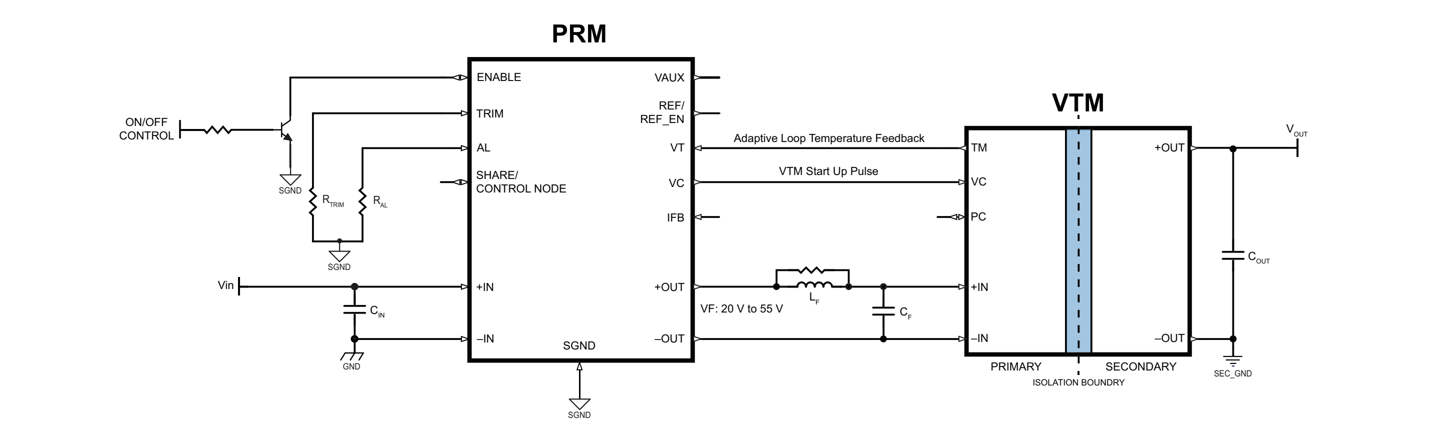


Figure 28 ? $" (%37-9) 223 ;%0 3/)

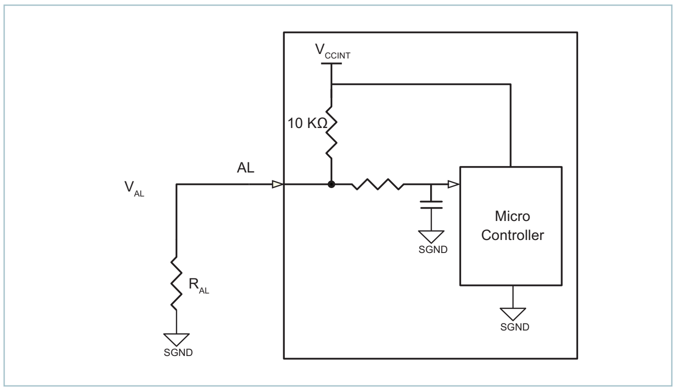


Figure 29 ? 211)'7-216

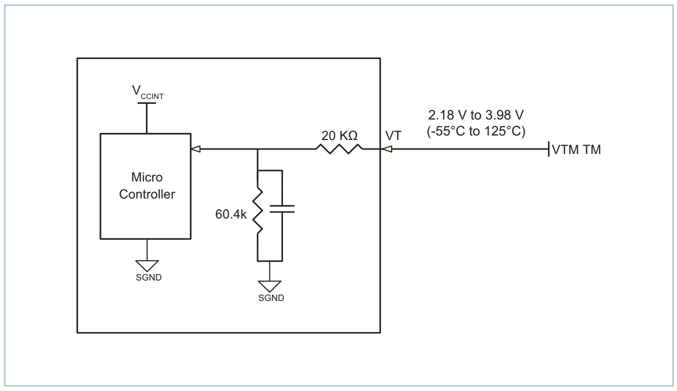


Figure 30 ? $" 211)'7-216

*; ? ;>3D FA +) $ # ;E E3 ? B>76 6GD;@9 7H7DK EF3DF GB FA 67F7D ? ;@7 ;8 F : 7 63BF;H7 #AAB >A36 ;@7 ;E 7@34>76 AD 6;E34>76 8 F : 7 # B;@ ;E 3>>A I 76 FA BG>> GB FA - AD : ;9 : 7D 6GD;@9 EF3DF GB F : 7@ F : 7@ F : 7 ') $ I ;>> 6;E34>7 F : 7 63BF;H7 #AAB >A36 >;@7 3E >A@9 3E F : 7 ') $ D7 ? 3;@E AB7D3F;@9 @ F : ;E 53E7 8AD 3>> EG4E7CG7@F AB7D3F;A@ F : 7 AGFBGF HA>F397 I ;>> 47 D7 ? 3;@ 3F F : 7 E7F HA>F397 3@6 F : 7 # B;@ I ;>> 47 ;9@AD76

+ : ;E E7>75F;A@ B7DE;EFE G@F;> F : 7 ') $;E D7EF3DF76 I ;F : F : 7 % # B;@ AD 6G7 FA 83G>F 3GFA D75AH7DK . : 7@ # ;E 7@34>76 F : 7 HA>F397 3F F : ;E B;@ ;E E3 ? B>76 3F _E ;@F7DH3>E FA 67F7D ? ;@7 F : 7 >A36 >;@7 + : 7 >A36 >;@7 53@ 47 36<GEF76 6GD;@9 @AD ? 3> AB7D3F;A@ : A I 7H7D ;F ;E @AF D75A ? ? 7@676 FA GE7 F : ;E B;@ ;@ 3@ 7JF7D@3> 3@3>A9 8776435= >AAB

Adaptive Loop Temperature Compensation (Adaptive Loop Operation)

K 5A@@75F;@9 F : 7 - + B;@ A8 F : 7 ') $ FA F : 7 - + $ E + $ B;@ F : 7 ') $;E 34>7 FA ? A@;FAD F : 7 ;@F7D@3> F7 ? B7D3FGD7 A8 F : 7 - + $ "@A I ;@9 F : 7 - + $ E ;@F7D@3> F7 ? B7D3FGD7 3@6 F : 7 F7 ? B7D3FGD7 5A788;5;7@F A8 F : 7 - + $ E) & , + I : ;5 : ;E BD7BDA9D3 ? ? 76 ;@FA F : 7 ') $ E ? ;5DA5A@FDA>>7D F : 7 # 7@9;@7 ;E 34>7 FA E53>7 F : 7 @A ? ;@3> H3>G7 A8) ##2 # E7F 4K F : 7 # B;@ FA FD35= F : 7 - + $ E) & , + AH7D F7 ? B7D3FGD7 @ F : ;E I 3K F : 7 AGFBGF D7E;EF3@57 A8 F : 7 ') $ 53@ 47 FG@76 FA 53@57> F : 7 AGFBGF D7E;EF3@57 A8 F : 7 - + $ I ;F : F : 7 366;F;A@ A8 3 E;@9>7 D7E;EFAD 35DAEE F : 7 # B;@ 3@6 3 5A@@75F;A@ A8 F : 7 - + $ E + $ B;@ FA F : 7 ') $ E - + B;@

+ : 7 - + $ + $ HA>F397 ;E 7CG3> FA F : 7 - + $;@F7D@3> E7@E76 F7 ? B7D3FGD7 ;@ "7>H;@ 6;H;676 4K AD 3 F7 ? B7D3FGD7 D3@97 A8 a FA a F : 7 + $ HA>F397 I ;>> D3@97 8DA ? - FA - + : 7 63BF;H7 #AAB F7 ? B7D3FGD7 5A ? B7@E3F;A@ ;E BD7 BDA9D3 ? 76 ;@FA F : 7 ;@F7D@3> ? ;5DA5A@FDA>>7D 3@6 ;E a 3EEG ? ;@9 F : 7 - + B;@ ;E 5A@@75F76 FA F : 7 + $ B;@ A8 3 5A ? B3F;4>7 - + $

+ : 7 + $ B;@ : 3E 3@ ;@F7D@3> BG>> 6A I @ FA * % 3@6 F7 ? B7D3FGD7 5A ? B7@E3F;A@ ;E 6;E34>76 8AD - + HA>F397E >7EE F : 3@ - +A 6;E34>7 F7 ? B7D3FGD7 5A ? B7@E3F;A@ >73H7 F : 7 - + B;@ G@5A@@75F76 3@6 AB7@ 5;D5G;F . : 7@ 6;E34>76 F : 7 F7 ? B7D3FGD7 6783G>FE a

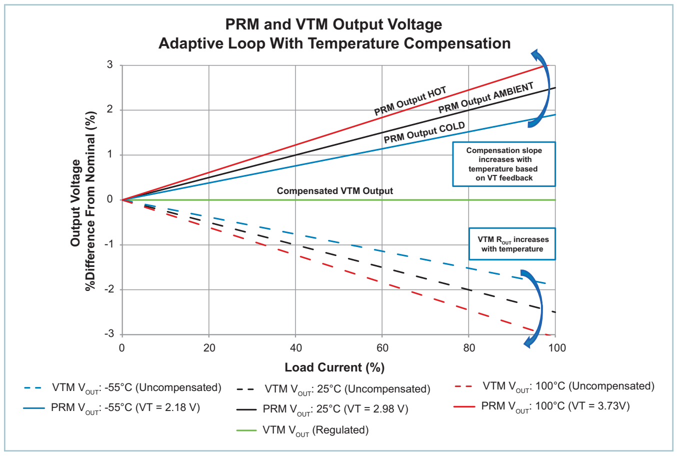


Figure 31 ? (%37-9) 223 ") 0 3)5%785) 2 0 3)16%7-21 //8675%7-21

+ : 7 6;E5GEE;A@ F : GE 83D A@>K 5A@E;67D76 F : 7 53E7 I : 7D7 F : 7 # 7@9;@7 ;E GE76 FA 5A ? B7@E3F7 8AD F : 7) & , + A8 F : 7 - + $ + : 7 # 7@9;@7 53@ 47 ? AD7 97@7D3>>K GE76 FA 355AG@F 8AD 6;EFD;4GF;A@ D7E;EF3@57E ;@ 4AF : F : 7 835FAD;L76 4GE 3@6 F : 7 - + $ E AGFBGF 6;EFD;4GF;A@ 4GE AD ? AD7 ;@8AD ? 3F;A@ A@ : A I FA 3BB>K F : 7 # 7@9;@7 FA I 3D6E F : ;E 7@6 B>73E7 5A@F35F - ;5ADE BB>;53F;A@E @9;@77D;@9 67B3DF ? 7@F

Stability Considerations and External Capacitance (Adaptive Loop Operation)

@ 63BF;H7 #AAB &B7D3F;A@ F : 7 ;@F7D@3> HA>F397 D79G>3F;A@ ;E 7@34>76 I : ;5 : 3E 3 BD7 67F7D ? ;@76 8;J76 5A ? B7@E3F;A@ @7F I AD= + : 7 5A ? B7@E3F;A@ ;E 67E;9@76 FA 47 EF34>7 AH7D 3 8;J76 E7F A8 AB7D3F;@9 3@6 >A36 5A@6;F;A@E ;@5>G6;@9 >A36 53B35;F3@57

7E;67E ;@F7D@3> AGFBGF 53B35;F3@57 7JF7D@3> AGFBGF 53B35;F3@57 3>EA 5A@FD;4GF7 FA F : 7 5>AE76 >AAB 8D7CG7@5K D7EBA@E7 F : GE E : AG>6 47 ;67@F;8;76 3@6 G@67DEFAA6 ;@ AD67D FA ? 3;@F3;@ F : 7 5A@FDA> >AAB EF34;>;FK + : ;E ;@5>G67E 53B35;F3@57 B>3576 6;D75F>K A@ F : 7 ') $ AGFBGF 3E I 7>> 3E 53B35;F3@57 A@ F : 7 AGFBGF A8 3@K 6A I @EFD73 ? - + $;8 GE76 D78>75F76 FA ;FE ;@BGF

;9GD7 ;>>GEFD3F7E F : 7 D7CG;D7 ? 7@FE 8AD 7JF7D@3> 53B35;FADE 8AD 4AF : F : 7 53B35;F3@57 3@6 *) H3>G7 E E : A I @ ;@ ;9GD7 3 F : 7 ? 3J; ? G ? 53B35;F3@57 H3>G7 A8 57D3 ? ;5 53B35;FAD ;E _ 3@6 F : 7 53B35;F3@57 A8 3 5A ? 4;@3F;A@ A8 57D3 ? ;5 3@6 7>75FDA>KF;5 53B35;FADE @776E FA 47 >7EE F : 3@ _ E E : A I @ ;@ ;9GD7 4 3@6 5 F : 7 *) H3>G7 A8 7>75FDA>KF;5 53B35;FADE @776E FA 47 47F I 77@] 3@6] F : 7 *) H3>G7 A8 57D3 ? ;5 53B35;FADE @776E FA 47 47F I 77@ ?] 3@6 ?]

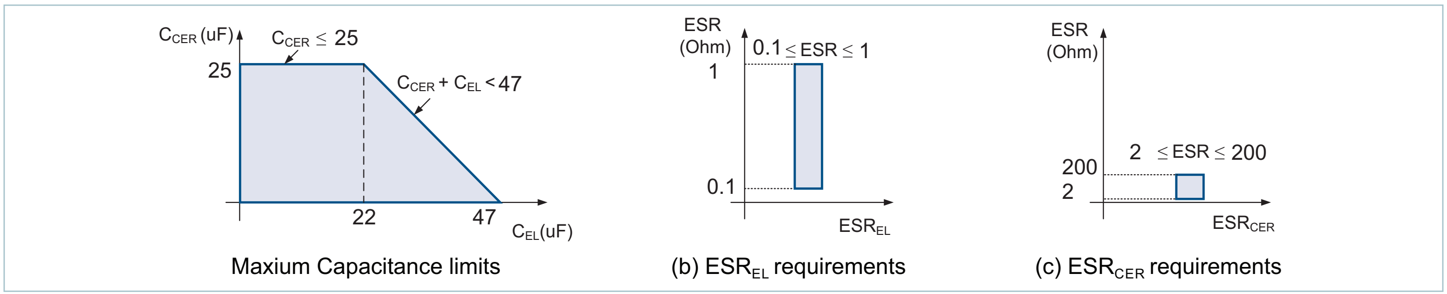


Figure 32 ? 87387 %3%'-7%1') -0-76

Current Limit (Adaptive Loop Operation)

@ 63BF;H7 #AAB &B7D3F;A@ F:7 5GDD7@F >; ? ;F ;E 5A@FDA>>76 4K F:7 ;@F7D@3> ? ;5DA5A@FDA>>7D +:7 5GDD7@F >; ? ;F 3BBDAJ; ? 3F7E 3 $4D;5= I 3>>T >; ? ;F I :7D7 F:7 AGFBGF 5GDD7@F ;E BD7H7@F76 8DA ? 5DAEE;@9 F:7 5GDD7@F >; ? ;F F:D7E:A>6 4K D76G5;@9 F:7 AGFBGF HA>F397 +:7 5GDD7@F >; ? ;F F:D7E:A>6 ;E BD7 BDA9D3 ? ? 76 ;@FA F:7 ;@F7D@3> ? ;5DA5A@FDA>>7D 3@6 53@@AF 47 5:3@976 7JF7D@3>>K

. :7@ F:7 ;@F7D@3> E7@E76 5GDD7@F 5DAEE7E F:7 5GDD7@F >; ? ;F F:D7E:A>6 F:7 5GDD7@F >; ? ;F I ;>> 47 35F;H3F76 38F7D F:7 67F75F;A@ F; ? 7 F# $2* , ' - &@57 35F;H3F76 F:7 ? ;5DA5A@FDA>>7D I ;>> D76G57 F:7 7DDAD 3 ? B>;8;7D D787D7@57 HA>F397 D7BD7E7@F76 4K) ;@ AD67D FA ? 3;@F3;@ F:7 AGFBGF 5GDD7@F 3F F:7 >; ? ;F H3>G7 GDD7@F >; ? ;F ;E 34>7 FA D76G57 F:7 AGFBGF 6A I @ FA - & , +2 , - ' 47>A I I :;5: F:7 67H;57 I ;>> E:GF 6A I @ 6A FA AGFBGF G@67D HA>F397 BDAF75F;A@

Soft Start Timing and Start up (Adaptive Loop Operation)

@ 63BF;H7 #AAB &B7D3F;A@ F:7 ') $:3E 3@ ;@F7D@3> EA8F EF3DF E7CG7@57 I :;5: ;E ;@;F;3F76 3F 7H7DK EF3DF GB +:;E 3>>A I E F:7 ') $ FA EF3DF ;@FA 8G>>K 6;E5:3D976 >A36 53B35;F3@57 +:7 EA8F EF3DF E7CG7@57 D3 ? BE F:7 AGFBGF 4K ? A6G>3F;@9 F:7 7DDAD 3 ? B>;8;7D D787D7@57 HA>F397) +:7 D7EG>F ;E F:3F F:7 ') $ AGFBGF I ;>> D;E7 3F 3 5A@FDA>>76 D3F7 G@F;> F:7 8;@3> HA>F397 E7FBA;@F ;E D735:76 +:7 FAF3> D3 ? B F; ? 7 ;E FKB;53>>K ? E ;@67B7@67@F A8 F:7 AGFBGF FD; ? >7H7> +:;E EA8F EF3DF D3 ? B F; ? 7 ;E BD7BDA9D3 ? ? 76 ;@FA F:7 ? ;5DA5A@FDA>>7D 3@6 53@@AF 47 5:3@976 7JF7D@3>>K

Load Transient Response (Adaptive Loop Operation)

@ 63BF;H7 #AAB &B7D3F;A@ D7EBA@E7 F; ? 7 ;E 67B7@67@F A@ F:7 ;@F7D@3> 5A ? B7@E3F;A@ . :7@ F:7 63BF;H7 #AAB >A36 >;@7 ;E 6;E34>76 F:7 ') $ AGFBGF HA>F397 I ;>> D75AH7D FA F:7 ;@;F;3> E7F H3>G7 3E ;>>GEFD3F76 ;@ ;9GD7 3@6 ;9GD7

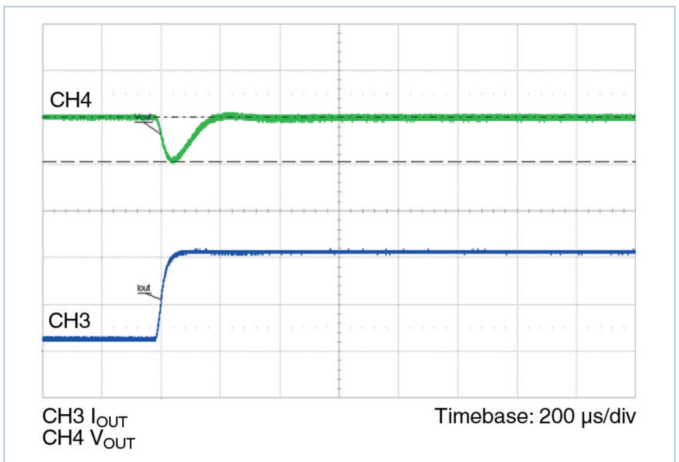


Figure 33 ? ;%03/) 72 2%("5%16-)17)63216) (%37-9) 223 2%(-1) -6%&/)(

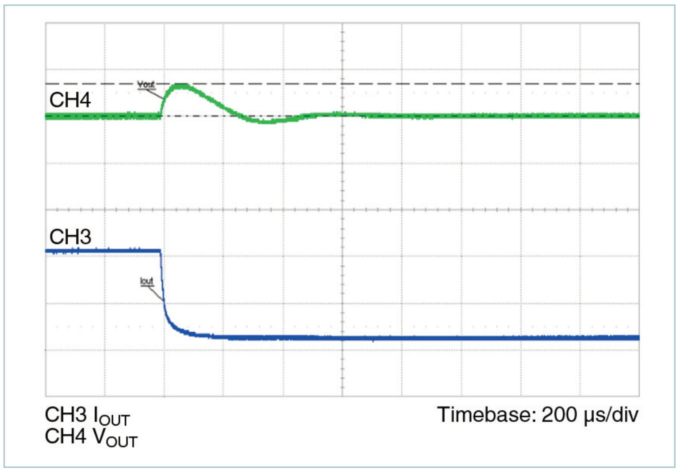


Figure 34 ? ;%03/) 72 2%("5%16-)17)63216) (%37-9) 223 2%(-1) -6%&/)(

. :7@ F:7 63BF;H7 #AAB >A36 >;@7 ;E 7@34>76 F:7 HA>F397 I ;>> D75AH7D FA F:7 H3>G7 67F7D ? ;@76 4K F:7 E7F BA;@F 3@6 63BF;H7 #AAB >A36 >;@7 E7FF;@9E 3E ;>>GEFD3F76 ;@ ;9GD7

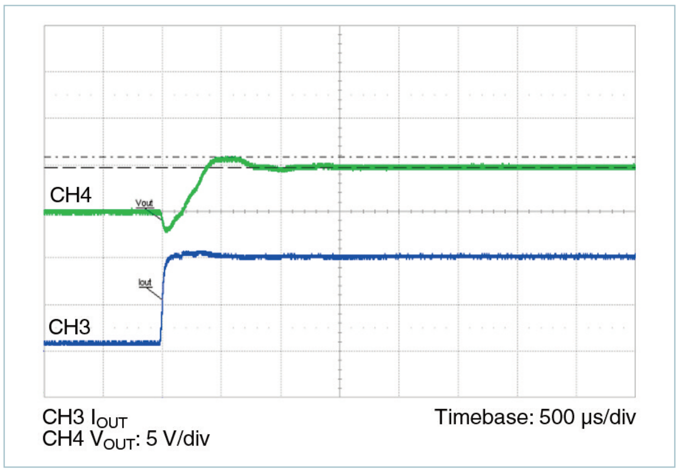


Figure 35 ? ;%03/) 72 2%("5%16-)17)63216) (%37-9) 223 2%(-1) 1%&/)($ $

5FG3> D7EBA@E7 F; ? 7E 3D7 ? A67> 67B7@67@F 3@6 I ;>> 5:3@97 43E76 A@ F:7 >A36 EF7B ? 39@;FG67 >A36 53B35;F3@57 3@6 AB7D3F;@9 5A@6;F;A@E

753GE7 F:7 5A ? B7@E3F;A@ ;E 8;J76 ;@F7D@3>>K F:7 >A36 FD3@E;7@F D7EBA@E7 53@@AF 47 3>F7D76 8AD 63BF;H7 #AAB &B7D3F;A@ @ AD67D FA ; ? BDAH7 F:7 >A36 FD3@E;7@F D7EBA@E7 B7D8AD ? 3@57 F:7 B3DF 53@ 47 5A@8;9GD76 8AD) 7 ? AF7 *7@E7 &B7D3F;A@ I ;F: 3@ 7JF7D@3> HA>F397 5A@FDA> >AAB ABF; ? ;L76 8AD F:7 EB75;8;5 ;@F7@676 AB7D3F;@9 5A@6;F;A@E) 7 ? AF7 *7@E7 &B7D3F;A@ ;E 67E5D;476 ;@ F:7 @7JF E75F;A@

Arrays (Adaptive Loop Operation)

@ 63BF;H7 #AAB AB7D3F;A@ 3 ? 3EF7D E>3H7 5A@8;9GD3F;A@ ;E GE76 8AD 3DD3KE , B FA ') $ E A8 F : 7 E3 ? 7 FKB7 ? 3K 47 B>3576 ;@ B3D3>>7> FA 7JB3@6 F : 7 BA I 7D 53B35;FK A8 F : 7 EKEF7 ?

&@7 ') $;E 67E;9@3F76 3E F : 7 ? 3EF7D 3@6 5A@F3;@E F : 7 35F;H7 5A@FDA> >AAB I : ;5 : 5A@E;67DE 5A@FDA> B;@ ;@BGFE 3@6 6D;H7E *) + : 7 AF : 7D ') $ E >;EF7@ FA *) 3@6 35F 3E E>3H7 BA I 7DFD3;@E A@>K + : 7 8A>>A I ;@9 : ;9 : >7H7> 9G;67>;@7E ? GEF 47 8A>>A I 76 ;@ AD67D 8AD F : 7 D7EG>F3@F EKEF7 ? FA EF3DF GB 3@6 AB7D3F7 BDAB7D>K 3@6 FA 3HA;6 AH7DEFD7EE AD 7J576;@9 3@K 34EA>GF7 ? 3J; ? G ? D3F;@9E

- &@7 ') $? GEF 47 67E;9@3F76 3E 3 ? 3EF7D F : DAG9 : 5A@8;9GD;@9 F : 7 +) $ B;@ HA>F397 I ;F : ;@ F : 7 D75A ? ? 7@676 D3@97
- >> AF : 7D ') $ E ? GEF 47 67E;9@3F76 3E E>3H7 ') $ E 4K FK;@9 +) $ B;@E FA * % F ;E D75A ? ? 7@676 FA ? 3=7 F : ;E 5A@@75F;A@ F : DAG9 : 3 ^ <G ? B7D 8AD FDAG4>7E : AAF;@9 BGDBAE7E
- >> ') $ E ;@ F : 7 3DD3K ? GEF 47 BA I 7D76 8DA ? 3 5A ? ? A@ BA I 7D EAGD57 EA F : 3F F : 7 ;@BGF HA>F397 FA 735 : ') $;E F : 7 E3 ? 7 + : 7 % B;@E A8 3>> ') $ E ? GEF 47 5A@@75F76 FA97F : 7D
- @ ;@67B7@67@F 8GE7 8AD 735 : ') $ % 5A@@75F;A@ ;E D7CG;D76 FA ? 3;@F3;@ E387FK 57DF;8;53F;A@ E77 GE;@9 E75F;A@
- @ ;@67B7@67@F ;@6G5FAD 8AD 735 : ') $ % 5A@@75F;A@ ;E D75A ? ? 7@676 I : 7@ GE76 ;@ 3@ 3DD3K FA 5A@FDA> 5;D5G>3F;@9 5GDD7@FE 3 ? A@9 F : 7 ') $;@BGFE 3@6 D76G57 F : 7 ; ? B35F A8 473F 8D7CG7@5;7E
- $;E ? 3F5 : 7E ;@ 4AF : ;@6G5F3@57 3@6 D7E;EF3@57 8DA ? F : 7 5A ? ? A@ BA I 7D EAGD57 FA 735 : ') $ E : AG>6 47 ? ;@; ? ;L76
- % # B;@E ? GEF 47 5A@@75F76 FA97F : 7D 8AD EF3DF GB EK@5 : DA@;L3F;A@ 3@6 BDAB7D 83G>F D7EBA@E7 A8 F : 7 3DD3K
- *) B;@E ? GEF 47 5A@@75F76 FA97F : 7D FA 7@34>7 E : 3D;@9 + : 7 43@6 I ;6F : D7CG;D7 ? 7@FE A8 *) 3D7 >A I 7@AG9 : F : 3F F : 7 4GE 53@ 47 5A@E;67D76 3 >G ? B76 7>7 ? 7@F D3F : 7D F : 3@ 3 FD3@E ? ;EE;A@ >;@7 3@6 EA EF3D 5A@@75F;A@E FA F : 7 ? 3EF7D ') $ I ;F : EFG4E 3E I 7>> 3E 63;EK 5 : 3;@ 5A@@75F;A@E 3D7 B7D ? ;FF76
- + : 7 D7E;EF3@57 47F I 77@ E>3H7 G@;F *) B;@E 3@6 F : 7 ? 3EF7DE E : AG>6 47 I 7>> ? 3F5 : 76 FA 3HA;6 ;@FDA6G5;@9 366;F;A@3> E : 3D;@9 ? ;E ? 3F5 : 7E + : 7 *) 4GE E : AG>6 @AF 47 DAGF76 G@67D 3@K ') $ *) 4GE B3D3E;F;5 53B35;F3@57 FA % AD & , + E : AG>6 47 ? ;@; ? ;L76
- * % A8 F : 7 ? 3EF7D ') $;E F : 7 D787D7@57 8AD 3>> 5A@FDA> >AAB 8G@5F;A@E + : 7 * % B;@E A8 735 : E>3H7 ') $ E E : AG>6 47 5A@@75F76 FA F : 7 * % D787D7@57 @A67 A@ F : 7 4A3D6 F : DAG9 : 3 ^ D7E;EFAD
- . : 7@ AB7D3F;@9 I ;F : ;@ 3@ 3DD3K F : 7 ? 3EF7D ') $;E D3F76 8AD 8G>> BA I 7D I : ;>7 F : 7 E>3H7 ') $ E 3D7 67 D3F76 FA F : 7 3DD3K D3F76 BA I 7D 3@6 5GDD7@F H3>G7E BDAH;676 8AD *>3H7 &B7D3F;A@ ' & , +2)) 0 & , +2)) 0 + : 7 @G ? 47D A8 ') $ E D7CG;D76 FA 35 : ;7H7 3 9;H7@ 3DD3K 53B35;FK ? GEF 5A@E;67D F : 7E7 67 D3F;@9E FA 3HA;6 AH7DEFD7EE;@9 3@K ') $;@ F : 7 3DD3K
- 63BF;H7 #AAB 67E;9@ BDA576GD7E 34AH7 I ;>> : A>6 8AD 3@ 3DD3K ;@ 97@7D3> 3>F : AG9 : EA ? 7 B3D3 ? 7F7DE ? GEF 47 E53>76 393;@EF F : 7 @G ? 47D A8 ') $ E ;@ F : 7 EKEF7 ?

DD3KE A8 ? AD7 F : 3@ ') $ E ? 3K 47 BAEE;4>7 F : DAG9 : GE7 A8 7JF7D@3> 5;D5G;FDK '>73E7 5A@F35F - ;5AD BB>;53F;A@E 8AD 3EE;EF3@57 I ;F : 3DD3K E;L;@9 34AH7 G@;FE

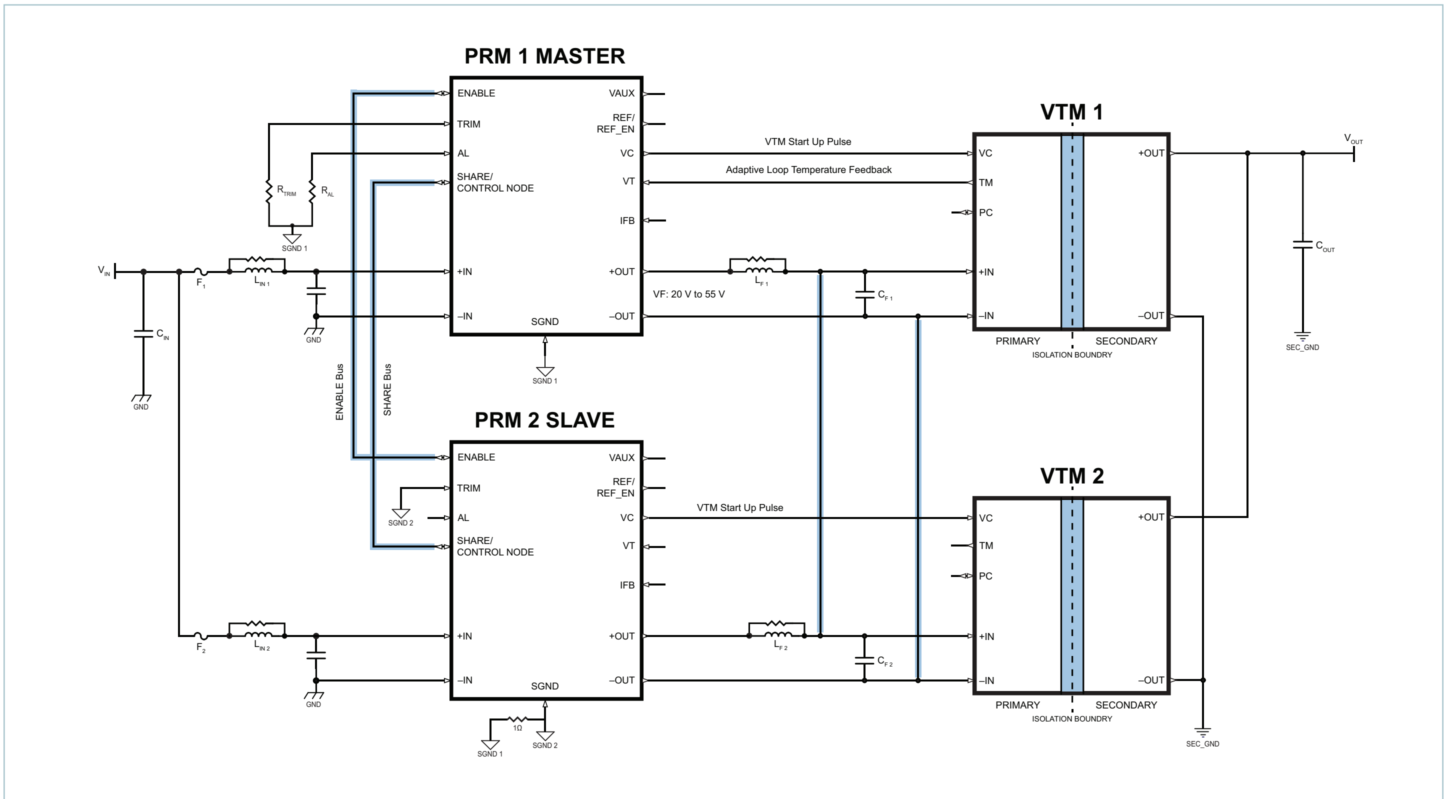


Figure 36 ? (%37-9) 223 55%< ;%0 3/)

Design Guidelines (Remote Sense Operation)

@)7?AF7 *7@E7 &B7D3F;A@ F:7 ') $! x ;E 3@ ;@F7>>;97@F BAI7DFD3;@ ?A6G>7 67E;9@76 FA 8G>>K 7JB>A;F 7JF7D@3> AGFBGF HA>F397 8776435= 3@6 5GDD7@F E7@E;@9 EG4 5;D5G;FE +:7E7 F I A 7JF7D@3> 5;D5G;FE 3D7 ;>>GEFD3F76 ;@ ;9GD7 I : ;5: E:AIE 3@ 7J3?B>7 A8 F:7 ') $;@ 3 EF3@63>A@7 3BB>;53F;A@ I ;F: >A53> HA>F397 8776435= 3@6 : ;9: E;67 5GDD7@F E7@E;@9

@ 97@7D3> F:7E7 5;D5G;FE ;@5>G67 3 BD75;E;A@ HA>F397 D787D7@57 3@ AB7D3F;A@3> 3?B>;8;7D I : ;5: BDAH;67E 5>AE76 >AAB 8776435= 5A?B7@E3F;A@ 3@6 3 : ;9: E;67 5GDD7@F E7@E7 5;D5G;F I : ;5: ;@5>G67E 3 E:G@F 3@6 5GDD7@F E7@E7

+:7 8A>>AI ;@9 67E;9@ BDA576GD7E D787D FA F:7 5;D5G;F E:AI @ ;@ ;9GD7

Setting the Output Voltage Level (Remote Sense Operation)

+:7 AGFBGF HA>F397 E7FBA;@F ;E 3 8G@5F;A@ A8 F:7 HA>F397 D787D7@57 3@6 F:7 AGFBGF HA>F397 E7@E7 D3F;A . ;F: D787D7@57 FA ;9GD7) 3@6) 8AD? F:7 AGFBGF HA>F397 E7@E;@9 6;H;67D I : ;5: BDAH;67E F:7 E53>76 AGFBGF HA>F397 FA F:7 @793F;H7 ;@BGF A8 F:7 7DDAD 3?B>;8;7D 3 676;53F76 D787D7@57 BDAH;67E F:7 D787D7@57 HA>F397 FA F:7 BAE;F;H7 ;@BGF A8 F:7 7DDAD 3?B>;8;7D , @67D @AD?3> AB7D3F;A@ F:7 7DDAD 3?B>;8;7D I ;>> =77B F:7 HA>F397E 3F F:7 ;@H7DF;@9 3@6 @A@ ;@H7DF;@9 ;@BGFE 7CG3> 3@6 F:7D78AD7 F:7 AGFBGF HA>F397 ;E 678;@76 4K

$$V_{OUT} = V_{REF} \cdot \frac{R1 + R2}{R2}$$

%AF7 F:3F F:7 5A?BA@7@F) I ;>> 3>EA 835FAD ;@FA F:7 5A?B7@E3F;A@ 3E 67E5D;476 ;@ 3 >3F7D E75F;A@

F ;E ;?BADF3@F FA 3BB>K BDAB7D E>7 I D3F7 FA F:7 D787D7@57 HA>F397 D;E7 I :7@ F:7 5A@FDA> >AAB ;E ;@;F;3>>K 7@34>76 +:7 D75A? ?7@676 D3@97 8AD D787D7@57 D;E7 F;?7 ;E ?E FA ?E +:7 >A I 7D D;E7 F;?7 >;?;F I ;>> 7@EGD7 ABF;?;L76 ?A6G>3FAD F;?;@9 B7D8AD?3@57 6GD;@9 EF3DF GB 3@6 FA 3>>A I F:7 5GDD7@F >;?;F 873FGD7 F:DAG9: B;@ FA 8G>>K BDAF75F F:7 67H;57 6GD;@9 BA I 7D GB +:7 GBB7D D;E7 F;?7 >;?;F ;E @77676 FA 9G3D3@F77 3 EG88;5;7@F 835FAD;L76 4GE HA>F397 ;E BDAH;676 FA 3@K 6A I @EFD73? - + $;@BGF 478AD7 F:7 7@6 A8 F:7 - BG>E7

Setting the Output Current Limit and Overcurrent Protection Level (Remote Sense Operation)

@)7?AF7 *7@E7 &B7D3F;A@ F:7 ;@F7D@3> 5GDD7@F E7@E;@9 ;E 6;E34>76 3@6 3@ 7JF7D@3> 5GDD7@F E7@E7 3?B>;8;7D ?GEF 47 ;?B>7?7@F76 FA BDAH;67 8776435= FA F:7 B;@

+:7 5GDD7@F >;?;F 3@6 AH7D5GDD7@F BDAF75F;A@ E7F BA;@FE 3D7 >;@=76 3@6 E53>7 FA97F:7D 393;@EF F:7 5GDD7@F E7@E7 E:G@F 3@6 F:7 93;@ A8 F:7 5GDD7@F E7@E7 3?B>;8;7D +:7 AGFBGF A8 F:7 5GDD7@F E7@E7 BDAH;67E F:7 HA>F397 I : ;5: :3E - 2 # 3@6 - 2& F:D7E:A>6E 8AD F:7 F I A 8G@5F;A@E D7EB75F;H7>K +:7 E7F BA;@FE 3D7 F:7D78AD7 678;@76 4K

$$I_{IL} = \frac{V_{IFB\_IL}}{R_S \cdot G_{CS}}$$

3@6

$$I_{OC} = \frac{V_{IFB\_OC}}{R_S \cdot G_{CS}}$$

I :7D7 * ;E F:7 93;@ A8 F:7 5GDD7@F E7@E7 3?B>;8;7D

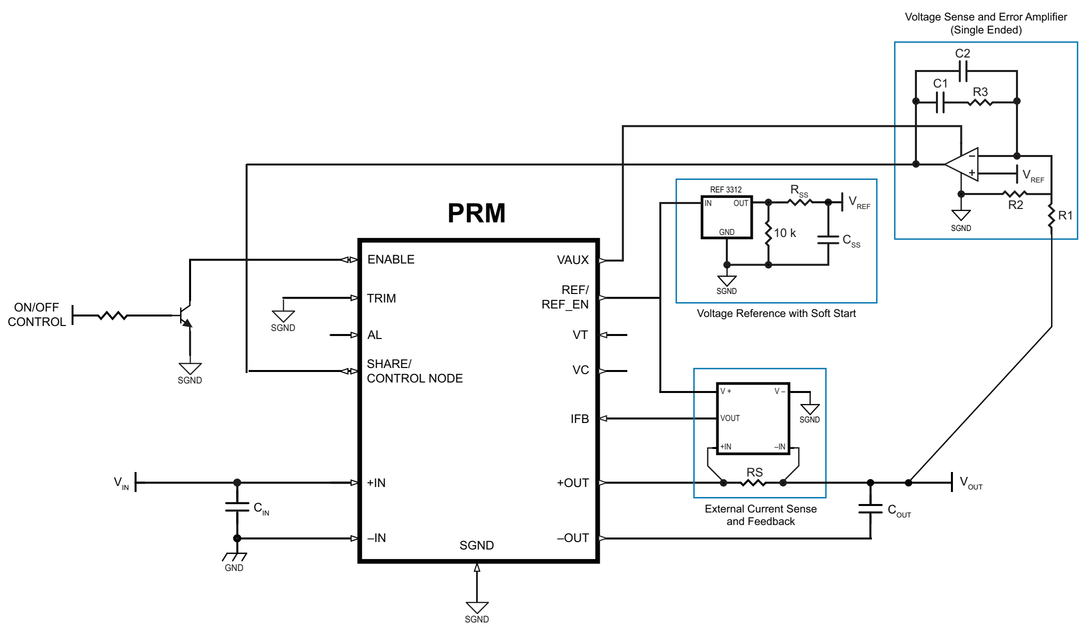


Figure 37 ?)027) !)16) ;%03/)

Control Loop Compensation Requirements (Remote Sense Operation)

@ AD67D FA BDAB7D>K 5A ? B7@E3F7 F : 7 5A@FDA> >AAB 3>> 5A ? BA@7@FE I : ;5 : 5A@FD;4GF7 FA F : 7 5>AE76 >AAB 8D7CG7@5K D7EBA@E7 E : AG>6 47 ;67@F;8;76 3@6 G@67DEFAA6 ;9GD7 E : A I E F : 7 E ? 3>> E;9@3> ? A67> 8AD F : 7 ? A6G>7 $ A6G>3FAD 93;@ % 3@6 BA I 7DFD3;@ 7CG;H3>7@F D7E;EF3@57 D (2& , + 3D7 E : A I @ + : 7E7 ? A67>;@9 B3D3 ? 7F7DE I ;>> EGBBADF 3 67E;9@ 5GF A88 8D7CG7@5K GB FA = L

*F3@63D6 A67 3@3>KE;E E : AG>6 47 GE76 8AD 53>5G>3F;@9 F : 7 7DDAD 3 ? B>;8;7D 5A ? B7@E3F;A@ 3@6 3@3>KL;@9 F : 7 5>AE76 >AAB EF34;>;FK + : 7 D75A ? ? 7@676 EF34;>;FK 5D;F7D;3 3D7 3E 8A>>A I E

' : 3E7 $ 3D9;@ Z 8AD F : 7 5>AE76 >AAB D7EBA@E7 F : 7 B : 3E7 E : AG>6 47 9D73F7D F : 3@ Z I : 7D7 F : 7 93;@ 5DAEE7E 6

3;@ $ 3D9;@ 6 + : 7 5>AE76 >AAB 93;@ E : AG>6 47 >A I 7D F : 3@ 6 I : 7D7 F : 7 B : 3E7 5DAEE7E Z

3;@ *>AB7 6 675367 + : 7 5>AE76 >AAB 93;@ E : AG>6 : 3H7 3 E>AB7 A8 6 675367 3F F : 7 5DAEEAH7D 8D7CG7@5K

+ : 7 5A ? B7@E3F;A@ 5 : 3D35F7D;EF;5E ? GEF 47 E7>75F76 FA ? 77F F : 7E7 EF34;>;FK 5D;F7D;3) 787D FA ;9GD7 8AD 3 >A53> E7@E7 HA>F397 ? A67 5A@FDA> 7J3 ? B>7 43E76 A@ F : 7 5A@8;9GD3F;A@ ;@ ;9GD7 @ F : ;E 7J3 ? B>7 ;F ;E 3EEG ? 76 F : 3F F : 7 ? 3J; ? G ? 5DAEEAH7D 8D7CG7@5K $ / : 3E 477@ E7>75F76 FA A55GD 47F I 77@ 3@6 +KB7 5A ? B7@E3F;A@ GDH7 ! " # ;E EG88;5;7@F ;@ F : ;E 53E7

+ : 7 8A>>A I ;@9 63F3 ? GEF 47 93F : 7D76 ;@ AD67D FA BDA5776

- $ A6G>3FAD 3;@ % *77 ;9GD7E
- ' A I 7DFD3;@ 7CG;H3>7@F D7E;EF3@57 D (*77 ;9GD7E
- @F7D@3> AGFBGF 53B35;F3@57 E77 ;9GD7
- JF7D@3> AGFBGF 53B35;F3@57 H3>G7

@ F : 7 53E7 A8 57D3 ? ;5 53B35;FADE F : 7 *) 53@ 47 5A@E;67D76 >A I 7@AG9 : FA BGE : F : 7 3EEA5;3F76 L7DA I 7>> 34AH7 F : 7 8D7CG7@5K A8 ;@F7D7EF BB>;53F;A@E I ;F : : ;9 : *) 53B35;FAD ? 3K D7CG;D7 3 6;887D7@F FKB7 A8 5A ? B7@E3F;A@ AD 53E5367 5A@FDA>

+ : 7 EKEF7 ? BA>7E 3@6 L7DAE 8A F : 7 5>AE76 >AAB 53@ F : 7@ 47 678;@76 3E 8A>>A I E

- ' A I 7DFD3;@ BA>7 3EEG ? ;@9 F : 7 7JF7D@3> 53B35;FAD *) 53@ 47 @79>75F76

$$R_{C_{OUT\_EXT}} << \frac{r_{EQ\_OUT} \cdot R_{LOAD}}{r_{EQ\_OUT} + R_{LOAD}}$$

- $ 3;@ BA>7 8D7CG7@5K

$$F_P \approx \frac{1}{2\pi \cdot \frac{r_{EQ\_OUT} \cdot R_{LOAD}}{r_{EQ\_OUT} + R_{LOAD}} \cdot \left(C_{OUT\_INT} + C_{OUT\_EXT}\right)}$$

- A ? B7@E3F;A@ $;6 3@6 3;@

$$G_{MB} = 20 \log \frac{R_3}{R_1}$$

- A ? B7@E3F;A@ 17DA

$$F_{Z1} = \frac{1}{2\pi \cdot R_3 \cdot C_1}$$

- A ? B7@E3F;A@ ' A>7

$$F_{P2} = \frac{1}{2\pi \cdot \frac{R_3 \cdot C_1 \cdot C_2}{C_1 + C_2}}$$

3@6 8AD $_1$ [

$$F_{P2} \approx \frac{1}{2\pi \cdot R_3 \cdot C_2}$$

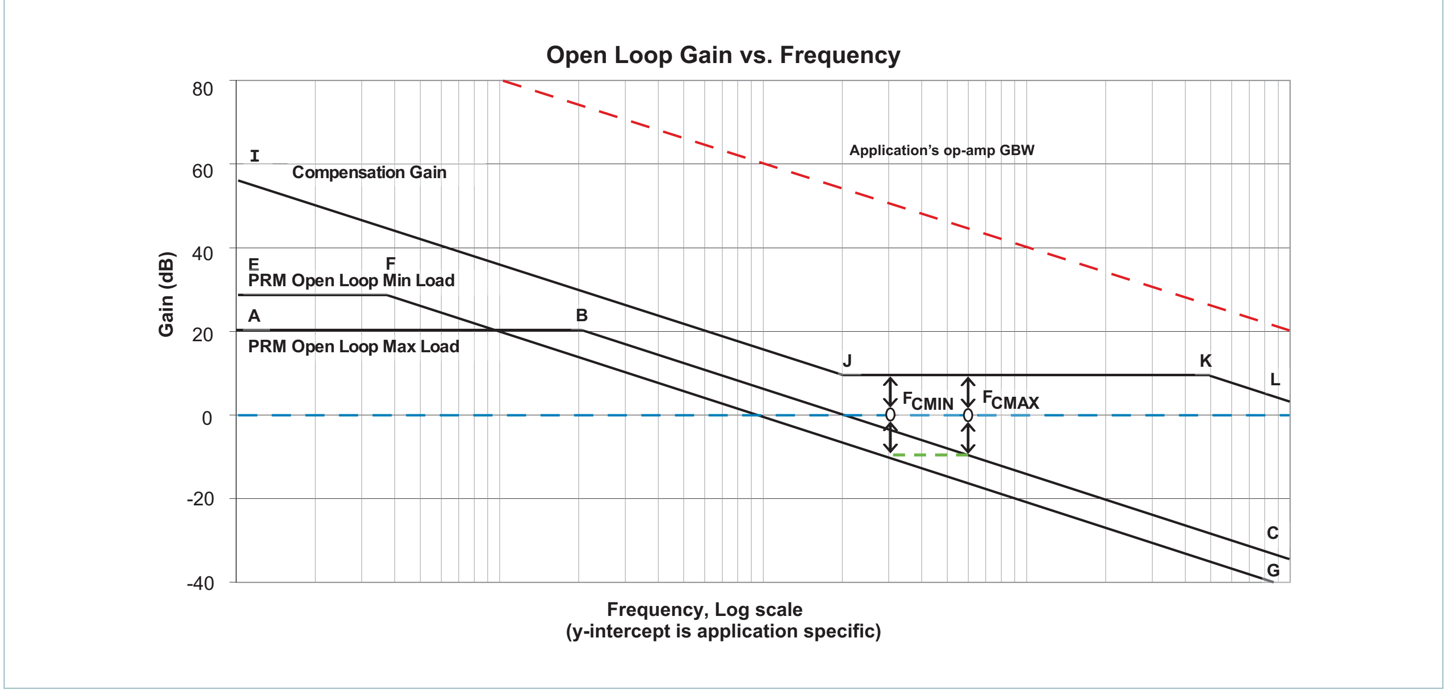


Figure 38 ?)*)5)1') %6<0 3727-' 2() 3/27 *25 7,) '216-()5)(6<67) 0

Midband Gain Design: R1, R3 (Remote Sense Operation)

. ;F: D787D7@57 FA ;9GD7 5GDH7 ;E F:7

- ? ;@; ? G ? AGFBGF HA>F397 ;@ F:7 3BB>;53F;A@
- ? 3J; ? G ? ;@BGF HA>F397 7JB75F76 ;@ F:7 3BB>;53F;A@
- ? 3J; ? G ? >A36

') $ AB7@ >AAB D7EBA@E7 3@6 ;E I :7D7 F:7 ? 3J; ? G ? 5DAEEAH7D 8D7CG7@5K A55GDE @ AD67D 8AD F:7 ? 3J; ? G ? 5DAEEAH7D 8D7CG7@5K FA A55GD 3F F:7 67E;9@ 5:A;57 $ / F:7 5A ? B7@E3F;A@ 93;@ ? GEF 47 7CG3> 3@6 ABBAE;F7 A8 F:7 BA I 7DFD3;@ 93;@ 3F F:;E 8D7CG7@5K AD EF34;>;FK BGDBAE7E F:7 5A ? B7@E3F;A@ E:AG>6 47 ;@ F:7 $;6 43@6 ! " 3F F:7 5DAEEAH7D , E;@9 CG3F;A@ F:7 ? ;6 43@6 93;@ 53@ 47 E7>75F76 3BBDABD;3F7>K

Compensation Zero Design :C1 (Remote Sense Operation)

. ;F: D787D7@57 FA ;9GD7 5GDH7 ;E F:7

- ? 3J; ? G ? AGFBGF HA>F397 ;@ F:7 3BB>;53F;A@
- ? ;@; ? G ? ;@BGF HA>F397 7JB75F76 ;@ F:7 3BB>;53F;A@
- ? ;@; ? G ? >A36 ;@ F:7 3BB>;53F;A@

') $ AB7@ >AAB D7EBA@E7 3@6 ;E I :7D7 F:7 ? ;@; ? G ? 5DAEEAH7D 8D7CG7@5K $ % A55GDE 3E76 A@ EF34;>;FK 5D;F7D;3 F:7 5A ? B7@E3F;A@ ? GEF 47 ;@ F:7 ? ;6 43@6 3F F:7 ? ;@; ? G ? 5DAEEAH7D 8D7CG7@5K F:7D78AD7 $ % I ;>> A55GD I :7D7 ;E 7CG3> 3@6 ABBAE;F7 A8 $ 53@ 47 E7>75F76 GE;@9 CG3F;A@ EA F:3F 1 A55GDE BD;AD FA $ %

High Frequency Pole Design: C2 (Remote Sense Operation):

, E;@9 CG3F;A@ E:AG>6 47 E7>75F76 EA F:3F ;E 3F >73EF A@7 675367 34AH7 $ / 3@6 BD;AD FA F:7 93;@ 43@6 I ;6F: BDA6G5F A8 F:7 AB7D3F;A@3> 3 ? B>;8;7D $ L 8AD F:;E 7J3 ? B>7 AD 3BB>;53F;A@E I ;F: 3 :;9:7D 67E;D76 5DAEEAH7D 8D7CG7@5K F:7 GE7 A8 3 :;9: 93;@ 43@6 I ;6F: BDA6G5F 3 ? B>;8;7D ? 3K 47 @757EE3DK FA 7@EGD7 F:3F F:7 D73> BA>7 53@ 47 E7F 3F >73EF A@7 675367 34AH7 F:7 ? 3J; ? G ? 5DAEEAH7D 8D7CG7@5K

Arrays (Remote Sense Operation)

@)7?AF7 *7@E7 &B7D3F;A@ GB FA ')$E A8 F:7 E3??7 FKB7 ?3K 47 B>3576 ;@ B3D3>>7> FA 7JB3@6 F:7 BAI7D 53B35;FK A8 F:7 EKEF7? >') $E I;F:;@ F:7 3DD3K 3D7 5A@8;9GD76 8AD)7??AF7 *7@E7 &B7D3F;A@ 3@6 3D7 6D;H7@ 4K 3@ 7JF7D@3> 5A@FDA> 5;D5G;F I:;5: 5A@E;67DE F:7 5A@FDA> ;@BGFE 3@6 6D;H7E F:7 &%+)&#%& 4GE +:7 8A>>AI;@9 :;9: >7H7> 9G;67>;@7E ?GEF 47 8A>>AI76 ;@ AD67D 8AD F:7 D7EG>F3@F EKEF7? FA EF3DF GB 3@6 AB7D3F7 BDAB7D>K 3@6 FA 3HA;6 AH7DEFD7EE AD 7J5776;@9 3@K 34EA>GF7 ?3J;?G? D3F;@9E

- >')$E ?GEF 47 5A@8;9GD76 8AD)7??AF7 *7@E7 &B7D3F;A@ 4K FK;@9 +) $ B;@E FA * % F;E D75A??7@676 FA ?3=7 F:;E 5A@@75F;A@ F:AG9: 3] <G?B7D 8AD FDAG4>7E:AAF;@9 BGDBAE7E
- >')$E ;@ F:7 3DD3K ?GEF 47 BAI7D76 8DA? 3 5A??A@ BAI7D EAGD57 EA F:3F F:7 ;@BGF HA>F397 FA 735: ')$;E F:7 E3??7
- @ ;@67B7@67@F 8GE7 8AD 735: ')$ % 5A@@75F;A@ ;E D7CG;D76 FA ?3;@F3;@ E387FK 57DF;8;53F;A@E E77 GE;@9 E75F;A@
- @ ;@67B7@67@F ;@6G5FAD 8AD 735: ')$ % 5A@@75F;A@ ;E D75A??7@676 I:7@ GE76 ;@ 3@ 3DD3K FA 5A@FDA> 5;D5G>3F;@9 5GDD7@FE 3?A@9 F:7 ')$;@BGFE 3@6 D76G57 F:7 ;?B35F A8 473F 8D7CG7@5;7E
- $;E?3F5:7E ;@ 4AF: ;@6G5F3@57 3@6 D7E;EF3@57 8DA? F:7 5A??A@ BAI7D EAGD57 FA 735: ')$ E:AG>6 47 ?;@;?;L76
- % # B;@E ?GEF 47 5A@@75F76 FA97F:7D 8AD EF3DF GB EK@5:DA@;L3F;A@ 3@6 BDAB7D 83G>F D7EBA@E7 A8 F:7 3DD3K
-)787D7@57 EGBB>K FA F:7 5A@FDA> >AAB HA>F397 D787D7@57 3@6 5GDD7@F E7@E7 5;D5G;FDK ?GEF 47 7@34>76 I:7@ 3>> ?A6G>7E) 2 % B;@E :3H7 D735:76 F:7;D AB7D3F;A@3> HA>F397 >7H7>E
- E;@9>7 7JF7D@3> 5A@FDA> 5;D5G;F ?GEF 47 ;?B>7?7@F76 3E 67E5D;476 ;@ F:7)7??AF7 *7@E7 &B7D3F;A@ 67E;9@ 9G;67>;@7E +:7 5A@FDA> 5;D5G;F E:AG>6 6D;H7 F:7 &%+)&#%& 4GE
- &%+)&#%& B;@E ?GEF 47 5A@@75F76 FA97F:7D FA 7@34>7 E:3D;@9 +:7 43@6I;6F: D7CG;D7?7@FE A8 &%+)&#%& 3D7 >AI 7@AG9: F:3F F:7 4GE 53@ 47 5A@E;67D76 3 >G?B76 7>7?7@F D3F:7D F:3@ 3 FD3@E?;EE;A@ >;@7 3@6 EA 5A@@75F;A@E 3E I7>> 3E 63;EK 5:3;@ 5A@@75F;A@E 3D7 B7D?;FF76
- 35: ')$?GEF :3H7 ;FE AI@ >A53> 5GDD7@F E:G@F 3@6 5GDD7@F E7@E7 5;D5G;FDK FA 6D;H7 ;FE B;@
- +:7 D7E;EF3@57 47FI77@ &%+)&#%& B;@E E:AG>6 47 I7>> ?3F5:76 FA 3HA;6 ;@FDA6G5;@9 366;F;A@3> E:3D;@9 ?;E?3F5:7E +:7 &%+)&#%& 4GE E:AG>6 @AF 47 DAGF76 G@67D 3@K ')$ '3D3E;F;5 53B35;F3@57 FA % AD &,+ E:AG>6 47 ?;@;?;L76
- &@7 ')$ E:AG>6 47 67E;9@3F76 FA BDAH;67 F:7 * % D787D7@57 - ,/ 3@6) 2 % HA>F397 8AD F:7 7JF7D@3> 5;D5G;FDK
- +:7 * % B;@E A8 735: ')$ E:AG>6 47 5A@@75F76 FA F:7 * % D787D7@57 @A67 A@ F:7 4A3D6 F:DAG9: 3] D7E;EFAD
- .:7@ AB7D3F;@9 I;F:;@ 3@ 3DD3K F:7 ')$E 3D7 67 D3F76 FA F:7 3DD3K D3F76 BAI7D 3@6 5GDD7@F H3>G7E BDAH;676 8AD)7??AF7 *7@E7 &B7D3F;A@ '&,+)) 0 &,+)) 0 +:7 @G?47D A8 ')$E D7CG;D76 FA 35:;7H7 3 9;H7@ 3DD3K 53B35;FK ?GEF 5A@E;67D F:7E7 67 D3F;@9E FA 3HA;6 AH7DEFD7EE;@9 3@K ')$;@ F:7 3DD3K
- .:7@ GE;@9 - ,/ FA BAI7D 7JF7D@3> 5;D5G;FDK FAF3> 5GDD7@F 6D3I ;@5>G6;@9 &%+)&#%& E;@= 5GDD7@FE ?GEF 47 F3=7@ ;@FA 355AG@F FA 7@EGD7 F:7 ?3J;?G? - ,/ 5GDD7@F ;E @AF 7J577676 DD3KE A8 ?AD7 F:3@ ')$E ?3K D7CG;D7 366;F;A@3> 5;D5G;FDK FA BDAH;67 F:7 D7CG;D76 EAGD57 5GDD7@F A@F35F -;5AD BB>;53F;A@E @9;@77D;@9 8AD ?AD7 ;@8AD?3F;A@

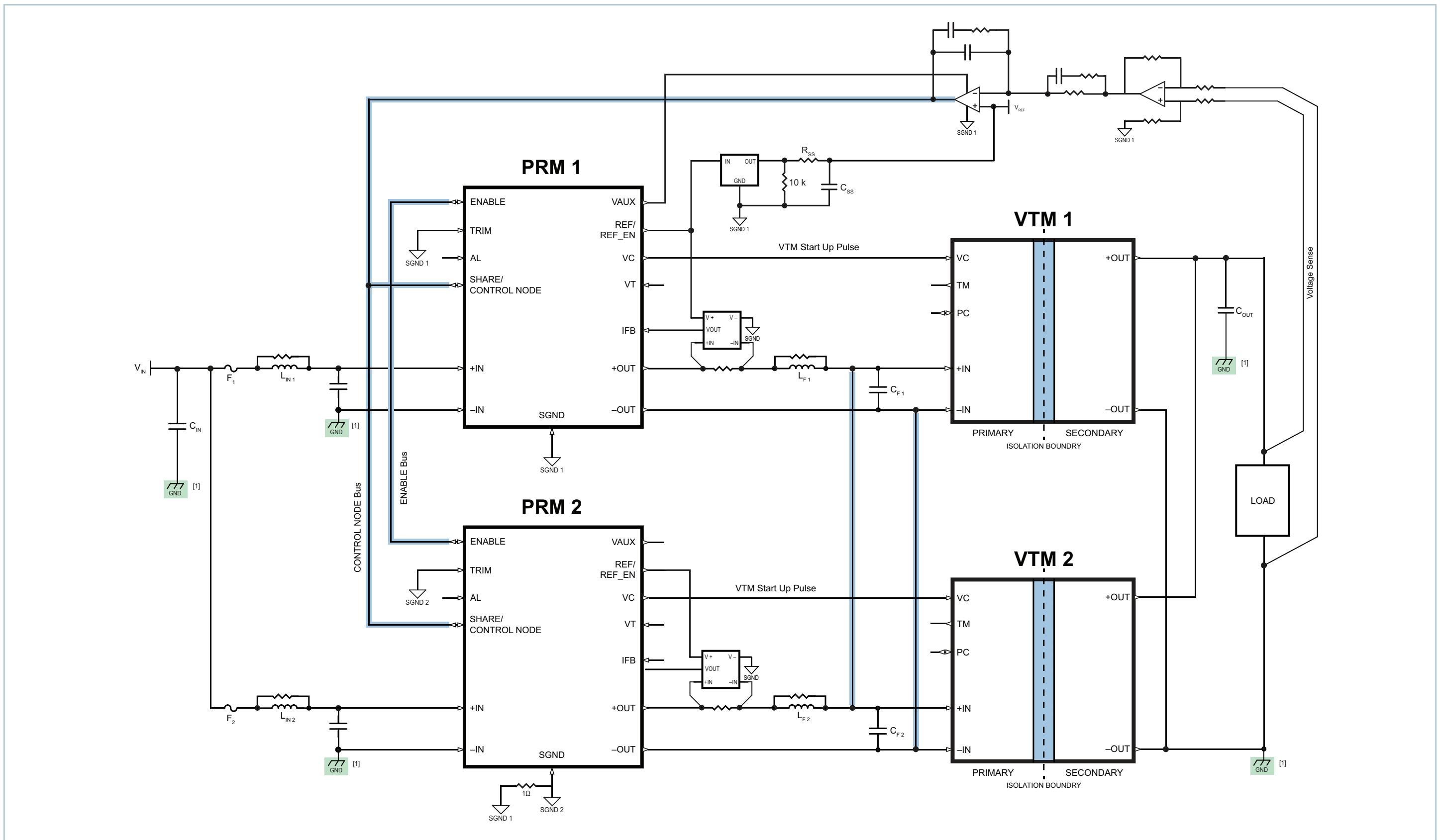


Figure 39 ? 21 62/%7)( )027) !)16) 55%< ;%03/)

[1] Non-Isolated Configuration: –Out connected to -IN

DESIGN GUIDELINES (General Operation)

+ : 7 8A»A I ;@9 9G;67>;@7E 3D7 97@7D3> 9G;67>;@7E F : 3F 3BB>K FA 3@K ? A67 A8 AB7D3F;A@

FPA System Considerations

+ : 7D7 3D7 3 87 I EKEF7 ? >7H7> 67E;9@ 5A@E;67D3F;A@E F : 3F E : AG>6 47 53D78G»K 5A@E;67D76 I : 7@ GE;@9 3 ') $ 3@6 - + $ FA ; ? B>7 ? 7@F 3 35FAD;L76 ' A I 7D D5 : ;F75FGD7 ' EKEF7 ?

+ : 7 - B;@ A8 F : 7 ') $ E : AG>6 47 6;D75F>K 5A@@75F76 FA F : 7 - B;@ A8 F : 7 - + $ + : 7 ') $ 3@6 - + $ 5AAD6;@3F7 F : 7 EAb EF3DF E7CG7@57 A8 F : 7 ' EKEF7 ? F : DAG9 : F : ;E 5A@@75F;A@ 8 F : 7 - B;@E 3D7 @AF 5A@@75F76 F : 7 - + $ I ;» @AF EF3DF GB . : 7@ F : 7 ') $;E D736K FA EF3DF GB ;F 3BB>;7E 3 HA>F397 A@ - I : ;5 : 7@34>7E 3@6 BA I 7DE F : 7 - + $;E BA I 7DFD3;@ + : 7 ') $ F : 7@ BDA5776E FA D3 ? B GB ;FE AGFBGF HA>F397 b7D 3BBDAJ; ? 3F7>K ? E - D7FGD@E FA - 3@6 F : 7 - + $ 53@ F : 7@ 67D;H7 BA I 7D 6;D75F>K 8DA ? F : 7 835FAD;L76 4GE BDAH;676 F : 3F F : 7 835FAD;L76 4GE HA>F397 ;E 34AH7 F : 7 ? ;@; ? G ? EB75;N76 - + $ AB7D3F;@9 ;@BGF HA>F397 I : 7@ F : 7 - BG>E 7JB;D7E

» - + $ 83G>FE >3F5 : F : 7 - + $ BA I 7DFD3;@ AP @BGF BA I 7D FA F : 7 EKEF7 ? 3E 3 I : A>7 ? GEF 47 D75K5>76 AD F : 7 ') $ E : AG>6 47 6;E34>76 3@6 7@34>76 4K I 3K A8 ;FE % # B;@ ;@ AD67D FA D7EF3DF F : 7 EKEF7 ? F ;E D75A ? ? 7@676 F : 3F F : 7 HA>F397 A@ F : 7 835FAD;L76 4GE D7FGD@ FA L7DA 478AD7 F : 7 ') $;E D7 7@34>76 &F : 7D I ;E7 F : 7 EAb EF3DF A8 F : 7 EKEF7 ? ? 3K 47 5A ? BDA ? ;E76

) # N>F7D E : AG>6 47 B>3576 47F I 77@ F : 7 ') $ 3@6 - + $ FA >;A53»K ;EA>3F7 E I ;F5 : ;@9 D;BB>7 5GDD7@FE F : 3F 53@ ;@F7D87D7 I ;F : ? A6G>7 AB7D3F;A@ F ;E ; ? BADF3@F F : 3F F : 7 ;@6G5F3@57 : 3H7 3@ ; ? B763@57 F : 3F ;E ? G5 : 9D73F7D F : 3@ F : 3F A8 F : 7 ') $ AGFBGF 53B35;F3@57 3@6 - + $;@BGF 53B35;F3@57 3F F : 7 E I ;F5 : ;@9 8D7CG7@5;7E A8 F : 7 67H;57E D7E;EFAD E : AG>6 47 B>3576 ;@ E : G@F FA F : ;E ;@6G5FAD FA 63 ? B7@ F : 7 D7EA@3@F # F3@= AD ? AEF 53E7E @ ;@ B3D3»7> I ;F :] ;E EGQ5;7@F FA ;EA>3F7 F : 7 E I ;F5 : ;@9 D;BB>7 5GDD7@FE

Verifying Stability

>A36 EF7B FD3@E;7@F D7EBA@E7 53@ 47 GE76 ;@ AD67D FA 7EF; ? 3F7 EF34;>;FK

;9GD7 ;»GEFD3F7E 3@ 7J3 ? B>7 A8 3 >A36 EF7B D7EBA@E7 CG3F;A@ 53@ 47 GE76 FA BD76;5F F : 7 B : 3E7 ? 3D9;@ 43E76 A@ F : 7 D3F;A A8 F : 7 S=;5=T FA S6DAABT 3E 67N@76 ;@ ;9

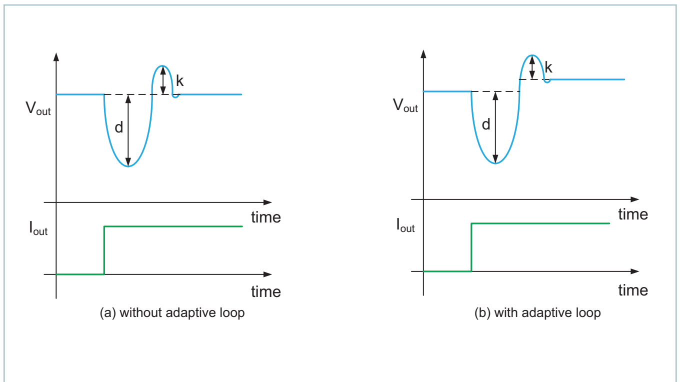


Figure 40 ? 2%(67)3 5)63216));%03/) %1(@(5223A 96 @.-'.A % : -7,287 (%37-9) 223 & : -7, (%37-9) 223

$$\Phi_m \approx 100\sqrt{\frac{\left(\ln\frac{k}{d}\right)^2}{\left(\ln\frac{k}{d}\right)^2+\pi^2}}$$

Burst Mode Operation

F>;9 : F >A36E F : 7 ') $ I ;» AB7D3F7 ;@ 3 4GDEF ? A67 6G7 FA ? ;@; ? G ? F; ? ;@9 5A@EFD3;@FE @ 7J3 ? B>7 4GDEF AB7D3F;A@ I 3H78AD ? ;E ;»GEFD3F76 ;@ ;9GD7

AD H7DK >;9 : F >A36E 3@6 3>EA 8AD : ;9 : 7D ;@BGF HA>F397E F : 7 ? ;@; ? G ? F; ? 7 BA I 7D E I ;F5 : ;@9 5K5>7 8DA ? F : 7 BA I 7DFD3;@ I ;» 7J5776 F : 7 BA I 7D D7CG;D76 4K F : 7 >A36 @ F : ;E 53E7 F : 7 7DDAD 3 ? B>;N7D I ;» B7D;A6;53»K 6;H7 *) &%) &# %& 47>A I F : 7 E I ;F5 : ;@9 F : D7E : A>6 ;@ AD67D FA ? 3;@F3;@ D79G>3F;A@ * I ;F5 : ;@9 I ;» 573E7 ? A ? 7@F3D;>K G@F;> F : 7 7DDAD 3 ? B>;N7D A@57 393;@ 6D;H7E *) &%+) &# %& HA>F397 34AH7 F : 7 F : D7E : A>6

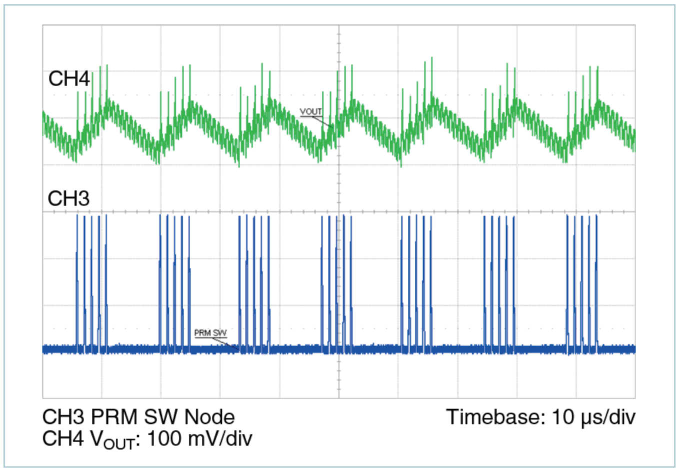


Figure 41 ? -+,7 /2%(&8567 02() 2* 23)5%7-21

%AF7 F : 3F 6GD;@9 F : 7 4GDEFE A8 E I ;F5 : ;@9 F : 7 BA I 7DFD3;@ 8D7CG7@5K ;E 5A@EF3@F 4GF F : 7 @G ? 47D A8 BG>E7E 3E I 7» 3E F : 7 F; ? 7 47F I 77@ 4GDEFE ;E H3D;34>7 + : 7 H3D;34;>;FK 67B7@6E A@ ? 3@K 835FADE ;@5>G6;@9 ;@BGF HA>F397 AGFBGF HA>F397E >A36 ; ? B763@57 3@6 7DDAD 3 ? B>;N7D AGFBGF ; ? B763@57

@ 4GDEF ? A67 F : 7 93;@ A8 F : 7 *) &%+) &# %& ;@BGF FA F : 7 B>3@F I : ;5 : ;E ? A67>76 ;@ F : 7 BD7H;AGE E75F;A@E ;E F; ? 7 H3DK;@9 + : 7D78AD7 F : 7 E ? 3» E;9@3> 3@3>KE;E 53@@AF 47 6;D75F>K 3BB>;76 FA 4GDEF ? A67 AB7D3F;A@

Input and Output filter design

;9GD7E 3@6 BDAH;67 F : 7 FAF3> ;@BGF 3@6 AGFBGF 5 : 3D97 B7D 5K5>7 3E I 7» 3E I ;F5 : ;@9 8D7CG7@5K A8 F : 7 ') $ 3F 8G» >A36 G@67D H3D;AGE ;@BGF 3@6 AGFBGF HA>F397E 5A@6;F;A@E ;9GD7 BDAH;67E F : 7 7P75F;H7 ;@F7D@3> 53B35;F3@57 A8 F : 7 ? A6G>7 5A@E7DH3F;H7 7EF; ? 3F7 A8 ;@BGF 3@6 AGFBGF B73= B73= HA>F397 D;BB>7 3F @A ? ;@3> >;@7 3@6 FD; ? ;E BDAH;676 4K 7CG3F;A@

$$\Delta V = \frac{Q_{TOT} - \dfrac{I_{FL}\cdot 0.4}{f_{SW}}}{C_{INT} + C_{EXT}}$$

(+&+ ;E F : 7 FAF3> ;@BGF ;9 AD AGFBGF ;9 5 : 3D97 B7D E I ;F5 : ;@9 5K5>7 3F 8G» >A36 I : ;>7 %+ ;E F : 7 ? A6G>7 ;@F7D@3> 7P75F;H7 53B35;F3@57 3F F : 7 5A@E;67D76 HA>F397 ;9 3@6 /+ ;E F : 7 7JF7D@3> 7P75F;H7 53B35;F3@57 3F F : 7 5A@E;67D76 HA>F397

Input Filter Stability

+ : 7 ') $ 53@ BDAH;67 H7DK : ;9 : 6K@3 ? ;5 FD3@E;7@FE F ;E F : 7D78AD7 H7DK ; ? BADF3@F FA H7D;8K F : 3F F : 7 HA>F397 EGBB>K EAGD57 3E I 7>> 3E F : 7 ;@F7D5A@@75F;@9 >;@7E 3D7 EF34>7 3@6 6A @AF AE5;>>3F7 AD F : ;E BGDBAE7 F : 7 5A@H7DF7D 6K@3 ? ;5 ;@BGF ; ? B763@57 ? 39@;FG67 $|r_{EQ\_IN}|$;E BDAH;676 ;@ ;9GD7E F ;E D75A ? ? 7@676 FA BDAH;67 367CG3F7 67E;9@ ? 3D9;@ I ;F : D7EB75F FA F : 7 EF34;>;FK 5A@6;F;A@E ;>>GEFD3F76 ;@ F : 7 BD7H;AGE E75F;A@

Inductive source and local, external input decoupling capacitance with negligible ESR (i.e.: ceramic type)

+ : 7 HA>F397 EAGD57 ; ? B763@57 53@ 47 ? A67>76 3E 3 E7D;7E) # % # # % 5;D5G;F + : 7 : ;9 : B7D8AD ? 3@57 57D3 ? ;5 675AGB>;@9 53B35;FADE I ;>> @AF E;9@;8;53@F>K 63 ? B F : 7 @7F I AD= 4753GE7 A8 F : 7;D >A I *) F : 7D78AD7 ;@ AD67D FA 9G3D3@F77 EF34;>;FK F : 7 8A>>A I ;@9 5A@6;F;A@ ? GEF 47 H7D;8;76

$$R_{line} > \frac{L_{line}}{(C_{IN\_INT} + C_{IN\_EXT}) \cdot |r_{EQ\_IN}|}$$

$$R_{line} << |r_{EQ\_IN}|$$

F ;E 5D;F;53> F : 3F F : 7 >;@7 EAGD57 ; ? B763@57 47 3F >73EF 3@ A5F3H7 >A I 7D F : 3@ F : 7 5A@H7DF7DE 6K@3 ? ;5 ;@BGF D7E;EF3@57 A I 7H7D) # % 53@@AF 47 ? 367 3D4;FD3D;>K >A I AF : 7D I ;E7 7CG3F;A@ ;E H;A>3F76 3@6 F : 7 EKEF7 ? I ;>> E : A I ;@EF34;>;FK 6G7 FA G@67D 63 ? B76) # ;@BGF @7F I AD=

Inductive source and local, external input decoupling capacitance with significant R_{CIN_EXT} ESR (i.e.: electrolytic type)

@ AD67D FA E; ? B>;8K F : 7 3@3>KE;E ;@ F : ;E 53E7 F : 7 HA>F397 EAGD57 ; ? B763@57 53@ 47 ? A67>76 3E 3 E; ? B>7 ;@6G5FAD # ;@7 %AF;57 F : 3F F : 7 : ;9 : B7D8AD ? 3@57 57D3 ? ;5 53B35;FADE %2 %+ I ;F : ;@ F : 7 ') $ E : AG>6 47 ;@5>G676 ;@ F : 7 7JF7D@3> 7>75FDA>KF;5 53B35;F3@57 H3>G7 8AD F : ;E BGDBAE7 + : 7 EF34;>;FK 5D;F7D;3 I ;>> 47

$$|r_{EQ\_IN}| > R_{C_{IN\_EXT}}$$

$$\frac{L_{line}}{C_{IN\_EXT} \cdot R_{C_{IN\_EXT}}} < |r_{EQ\_IN}|$$

CG3F;A@ E : A I E F : 3F ;8 F : 7 399D793F7 *) ;E FAA E ? 3>> U 8AD 7J3 ? B>7 4K GE;@9 H7DK : ;9 : CG3>;FK ;@BGF 53B35;FADE %2 / + U F : 7 EKEF7 ? I ;>> 47 G@67D 63 ? B76 3@6 ? 3K 7H7@ 475A ? 7 67EF34;>;L76 93;@ 3@ A5F3H7 A8 67E;9@ ? 3D9;@ ;@ E3F;E8K;@9 E : AG>6 47 5A@E;67D76 F : 7 ? ;@; ? G ?

Layout Considerations

BB>;53F;A@ %AF7 % 67F3;>E 4A3D6 >3KAGF D75A ? ? 7@63F;A@E GE;@9 - : ;BX 5A ? BA@7@FE I ;F : 67F3;>E A@ 9AA6 BA I 7D 5A@@75F;A@E D76G5;@9 $ 3@6 E : ;7>6;@9 A8 5A@FDA> E;9@3>E 3@6 F75 : @;CG7E FA D787D7@57 F : 7 ? FA * %

HA;6 DAGF;@9 5A@FDA> E;9@3>E % # +) $ # 7F5 6;D75F>K G@67D@73F : F : 7 ') $ F ;E 5D;F;53> F : 3F 3>> 5A@FDA> E;9@3>E 3E;67 8DA ? - 3@6 -+ 3D7 D787D7@576 FA * % 4AF : 8AD DAGF;@9 3@6 8AD BG>> 6A I @ 3@6 4KB3EE;@9 BGDBAE7E - 3@6 -+ BDAH;67 5A@FDA> 3@6 8776435= 8DA ? 3 -+$ 3@6 ? GEF 47 D787D7@576 FA U& , + A8 F : 7 ') $ % A8 F : 7 -+$

* % ;E 5A@@75F76 FA U % ;@F7D@3>>K FA F : 7 ') $ * % E : AG>6 @AF 47 F;76 FA 3@K AF : 7D 9DAG@6 ;@ F : 7 EKEF7 ?

Input Fuse Recommendations

8GE7 E : AG>6 47 ;@5ADBAD3F76 3F F : 7 ;@BGF FA 735 : ') $;@ E7D;7E I ;F : F : 7 % B;@ AD E ? 3>>7D ;@BGF 8GE7 #;FF7>8GE7X % %& X *7D;7E ;E D7CG;D76 FA E387FK 397@5K 5A@6;F;A@E A8 3557BF34;>;FK > I 3KE 3E57DF3;@ 3@6 A4E7DH7 F : 7 E387FK D79G>3FADK AD AF : 7D 397@5K EB75;8;53F;A@E F : 3F 3BB>K FA KAGD EB75;8;5 3BB>;53F;A@

Thermal Considerations

- : ;B BDA6G5FE 3D7 ? G>F; 5 : ;B ? A6G>7E I : AE7 F7 ? B7D3FGD7 6;EFD;4GF;A@ H3D;7E 9D73F>K 8AD 735 : B3DF @G ? 47D 3E I 7>> 3E I ;F : F : 7 ;@BGF AGFBGF 5A@6;F;A@E F : 7D ? 3> ? 3@397 ? 7@F 3@6 7@H;DA@ ? 7@F3> 5A@6;F;A@E $ 3@F3;@;@9 F : 7 FAB A8 F : 7 ') $! x 53E7 FA >7EE F : 3@ Z I ;>> =77B 3>> <G@5F;A@E I ;F : ;@ F : 7 - : ;B ? A6G>7 47>A I Z 8AD ? AEF 3BB>;53F;A@E + : 7 B7D57@F A8 FAF3> : 73F 6;EE;B3F76 F : DAG9 : F : 7 FAB EGD8357 H7DEGE F : DAG9 : F : 7 ! >736 ;E 7@F;D7>K 67B7@67@F A@ F : 7 B3DF;5G>3D ? 75 : 3@;53> 3@6 F : 7D ? 3> 7@H;DA@ ? 7@F + : 7 : 73F 6;EE;B3F76 F : DAG9 : F : 7 FAB EGD8357 ;E FKB;53>>K + : 7 : 73F 6;EE;B3F76 F : DAG9 : F : 7 ! >736 A@FA F : 7 ' 4A3D6 EGD8357 ;E FKB;53>>K , E7 FAB EGD8357 6;EE;B3F;A@ I : 7@ 67E;9@;@9 8AD 3 5A@E7DH3F;H7 5AA>;@9 EA>GF;A@

F ;E @AF D75A ? ? 7@676 FA GE7 3 - : ;B ? A6G>7 8AD 3@ 7JF7@676 B7D;A6 A8 F; ? 7 3F 8G>> >A36 I ;F : AGF BDAB7D : 73F E;@=;@9

Line Dropout Operation

+:7 ')$! x ;E ABF;?;L76 8AD BAEF ' AB7D3F;A@ I:7D7 :A>6GB 53B35;F3@57 ;E >A53F76 A@ F:7 - 4GE +:7 ')$! x ;E 53B34>7 A8 AB7D3F;@9 6A I@ 3E >A I 3E - % 8AD GB FA ?E ;@ AD67D FA BDAH;67 7JF7@676 :A>6GB 53B35;FK 6GD;@9 3@ >;@7 6DABAGF

GD;@9 3@ >;@7 6DABAGF A@57 F:7 ;@BGF HA>F397 5DAEE7E - 3 ?EF;?7DF)&'&,+ ;E 7@34>76

8F:7 ;@BGF D75AH7DE 34AH7 F:7 D75AH7DK F:D7E:A>6 I;F:;@ ?E F:7@ F:7 F;?7D ;E 6;E34>76 3@6 @AD?3> AB7D3F;A@ D7EG?7E &F:7 D I;E7 ;8 F:7 ;@BGF HA>F397 83;>E FA D735: F:7 D75AH7DK F:D7E:A>6 AD ;8 F:7 G@67DHA>F397 >A5=AGF F:D7E:A>6 ;E 5DAEE76 BA I 7DFD3;@ E:GF6A I@ ;E ;@;F;3F76

;9GD7 ;>>GEFD3F7E >;@7 6DABAGF 5A@6;F;A@E

a) +:7 ;@BGF D75AH7DE 34AH7 F:7 D75AH7DK F:D7E:A>6 478AD7 F)&'&,+ 7JB;D7E 3@6 @AD?3> AB7D3F;A@ D7EG?7E
b) F)&'&,+ 7JB;D7E 478AD7 F:7 ;@BGF D735:7E F:7 D75AH7DK F:D7E:A>6 3@6 F:7 BA I 7DFD3;@ E:GFE 6A I@
c) - % 5DAEE7E F:7 - %2,-#& F:D7E:A>6 3@6 F:7 BA I 7DFD3;@ E:GFE 6A I@

GD;@9 #;@7 DABAGF &B7D3F;A@ AGFBGF 5GDD7@F 3@6 BA I 7D 3D7 >;@73D>K 67 D3F76 FA 47F I 77@ - 3@6 - 3E EB75;8;76 ;@ ;9GD7

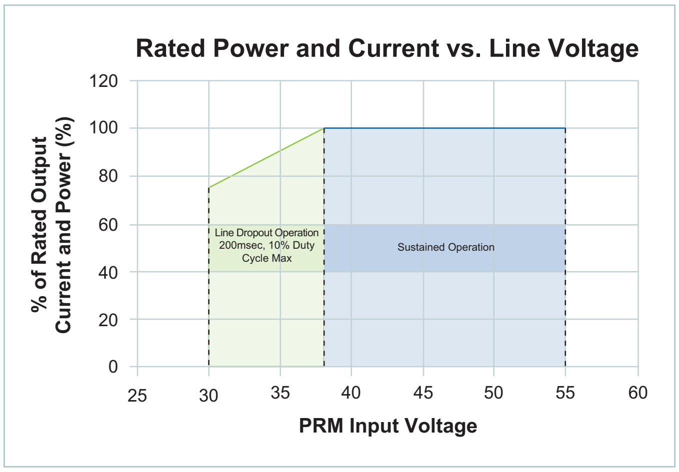


Figure 42 ? -1) 523287)5%7-1+

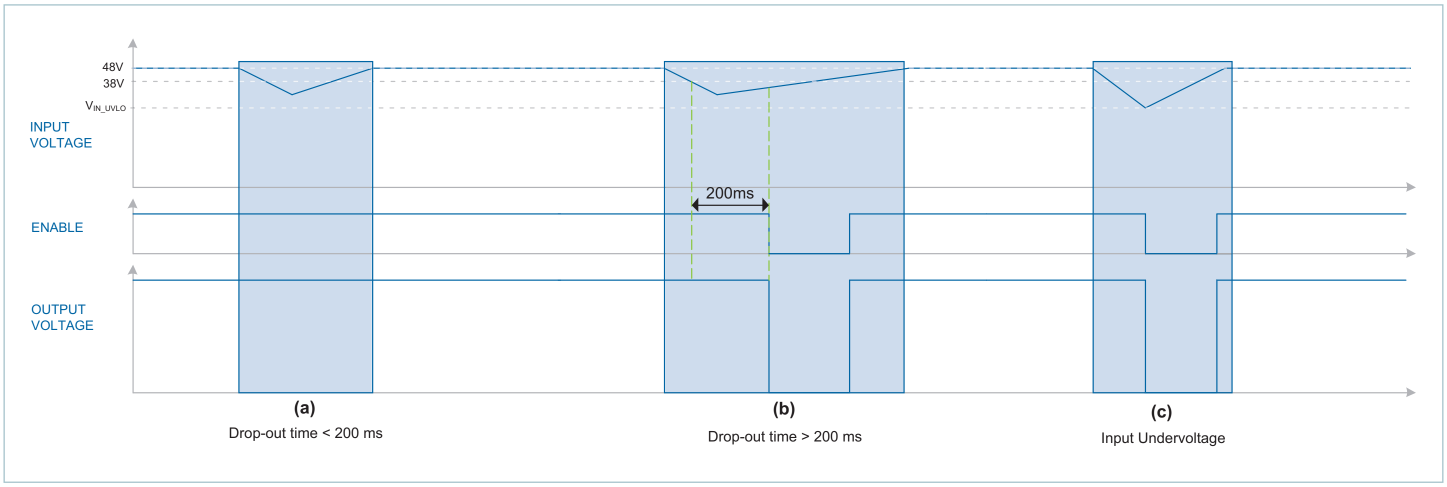
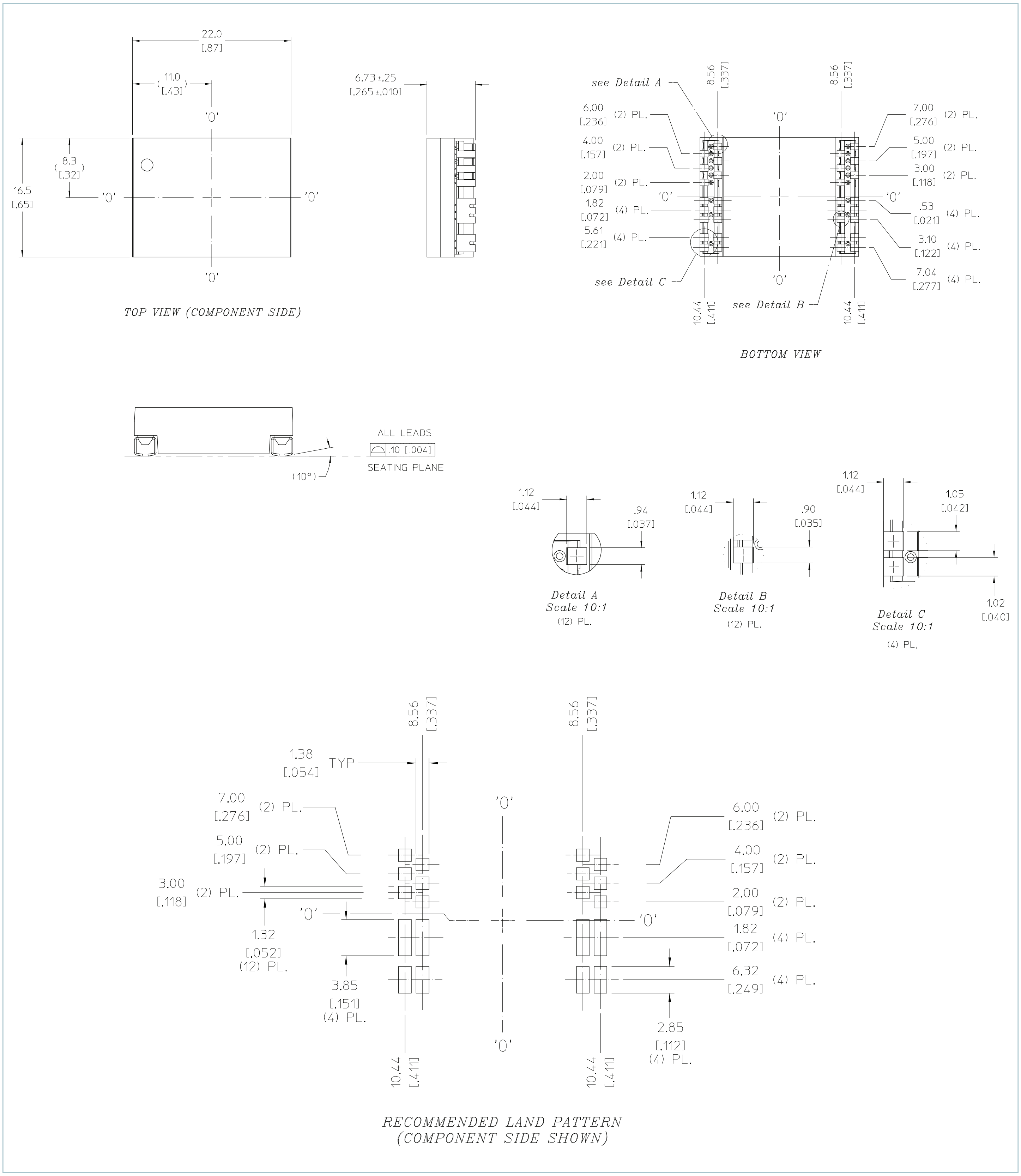


Figure 43 ? -1) 523287 3)5%7-21 "-0-1+ -%+5%0

Product Outline Drawing and Recommended Land Pattern



Revision History

Revision	Date	Description	Page Number(s)
1.0	07/24/13	Final approved data sheet for intital release	n/a
1.1	09/30/15	Updated MSL Rating	27
1.2	11/18/15	Corrections to schematic labels	17

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