Panasonic

NN32251A

http://www.semicon.panasonic.co.jp/en/

INTEGRATED WIRELESS POWER SUPPLY TRANSMITTER, Qi (WIRELESS POWER CONSORTIUM) COMPLIANT

FEATURES

- Integrated wireless power transmitter controller
- WPC Ver. 1.1 ready
- MCU embedded
- Half-bridge gate driver : 4ch
  (full-bridge gate driver : 2ch also configurable)
- Single-coil (Type A11) supported
- Expanded free positioning using multi-coils up to 4 coils (Type A6)
- Highly accurate voltage and current monitor for inverters
- Output controlled by frequency or duty, defined in Qi.
- ASK demodulation for both current and voltage signals (Qi compliant)
- Input voltage range : VADP, VINV : 4.6 to 19.5V
- Supports Under Voltage Lockout , Thermal Shutdown, Over Current Detection
- Short-circuit protection at inverter output
- Temperature Detecting Circuit : 3ch
- LED indicator : 2ch
- package : 64 pins HQFP
  (size : 12mm × 12mm)

DESCRIPTION

NN32251A is a wireless power system controller IC which is compliant with Qi version 1.1 of the System Description Wireless Power Transfer, Volume 1 for Low Power, defined by Wireless Power Consortium.

NN32251A is a controller IC of a power transmitter (Tx) which can supply power to any Qi-compliant wireless chargers.

APPLICATIONS

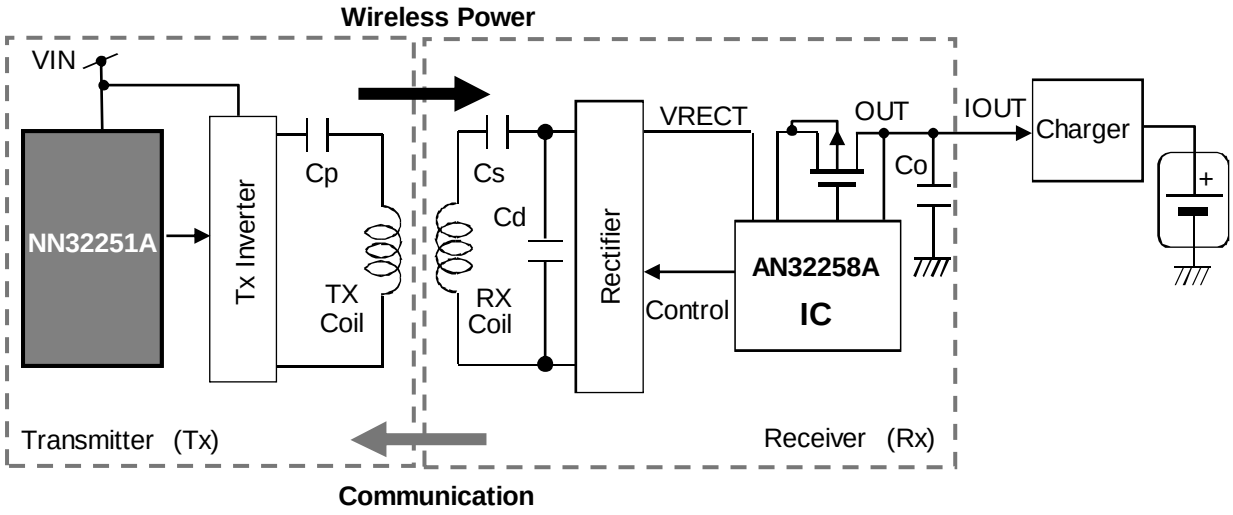
・WPC-compliant wireless charger

IMPORTANT

NN32251A is designed to be used based on the circuits and external components described in this document and Application Note.

Therefore, Panasonic cannot support any inquiries of modified solution.

Wireless Power System



DELIVERY INFORMATION

Order Number	Package	Output Supply	Minimum Quantity
NN32251A-VT	64 pin HQFP (12 × 12 mm)	Tray	500pcs

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Rating	Unit	Notes
Supply voltage	V_{VADP}	21	V	*1
	V_{VINV}	21	V	
Output current	I_{VADP}	—	A	*1
Operating ambient temperature	T_{opr}	– 30 to + 85	°C	*2
Operating junction temperature	T_j	−40 to +125	°C	*2
Storage temperature	T_{stg}	– 55 to + 125	°C	*2
Input voltage range	V_{SCDET1}, V_{SCDET2}, V_{SCDET3}, V_{SCDET4}, V_{CFB1}, V_{CFB2}, V_{VFB}	– 0.3 to 21	V	*1
	V_{TEST3}, $V_{SELLED1}$, V_{TYP1}, $V_{SELLED2}$, V_{NCO1}, V_{NCO2}, V_{PWR}, $V_{SELFOD1}$, $V_{SELFOD2}$, V_{TEST4}, V_{FWMD}, V_{TH1}, V_{TH2}, V_{TH3},	– 0.3 to 7	V	*1
	V_{TEST2}, V_{ENB}, V_{VMODIN}, V_{CMODIN}, V_{CSIN1}, V_{CSIN2}, V_{TEST}, V_{SMBC}, V_{SMBD},	– 0.3 to 4.6	V	*1
ESD	HBM (Human Body Model)	2	kV	—
	CDM (Charged Device Model)	1	kV	—

Note) This product may sustain permanent damage if the actual condition is higher than the absolute maximum rating stated above. This rating is the maximum stress, and device will not be guaranteed to operate in case it is higher than our stated range. When exposed to the absolute maximum rating for a long time, the reliability of the product may be affected.

No voltage or current input is allowed for the pins not listed above. All voltage ratings are relative to the ground level, which is referred to as GNDMC, GNDMOD, GNDA1, GNDA3, GNDP1, and GNDP2.

*1:The values are under the condition not exceeding the above absolute maximum ratings and the power dissipation.

*2:Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for Ta = 25 °C.

POWER DISSIPATION RATING

PACKAGE	θ_{j-a}	θ_{j-C}	PD (Ta = 25 °C)	PD (Ta = 85 °C)	Notes
HQFP64	25.5 °C / W	1.05 °C /W	4.90 W	2.55 W	*1

Note). For the actual usage, please refer to the PD-Ta characteristics diagram in the package specification, and follow the power supply voltage, load and ambient temperature conditions to ensure that there is enough margin and the thermal design does not exceed the allowable value.

*1 : glass epoxy board (4 layers) [50 × 50 × 0.8 t (mm)]

CAUTION

Although this device has limited built-in ESD protection circuit, permanent damage may occur on it. Therefore, proper ESD precautions are recommended to avoid electrostatic damage to the MOS gates

RECOMMENDED OPERATING CONDITIONS

Parameter	Pin Name	Min.	Typ.	Max.	Unit	Notes
Supply voltage range	V_{VADP}, V_{VINV}	4.6	12	19.5	V	*2

Note) *2 :The values are under the condition not exceeding the above absolute maximum ratings and the power dissipation.

ELECRTRICAL CHARACTERISTICS

V_{VADP} = 12 V, V_{VINV} = 12 V, T_a = 25 °C ± 2 °C unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
Current Consumption							
Quiescent current	I_{STBY}	ENB=L	6.48	8.10	9.72	mA	
Operating current	I_{OPR}	ENB=H	18.0	22.6	27.0	mA	
Half-Bridge Gate Driver							
Minimum switching frequency	F_{SWMIN}		108	110	112	kHz	
Maximum switching frequency	F_{SWMAX}		200	205	210	kHz	
Accuracy of switching frequency	F_{SWCA}		—	—	0.4	kHz	
Minimum duty	DR_{MIN}		—	—	10	%	
Maximum duty	DR_{MAX}		50	—	—	%	
High-side Output – H level	V_{HSH}	I_{source}=1mA	V_{VINV} -0.3	—	—	V	
High-side Output – L level	V_{HSL}	I_{sink}=1mA	—	—	V_{VINV} -4.7	V	
Low-side Output – H level	V_{LSH}	I_{source}=1mA	3.8	—	—	V	
Low-side Output – L level	V_{LSL}	I_{sink}=1mA	—	—	0.2	V	
LDO4.1V							
Output voltage	V_{OUT41}	I_{out}=20mA	4.0	4.1	4.2	V	
LDO3.3V (for internal circuit)							
Output voltage	V_{OUT33}	I_{out}=1mA	3.2	3.3	3.4	V	
LDO1.8V (for internal circuit)							
Output voltage	V_{OUT18}	I_{out}=1mA	1.7	1.8	1.9	V	

ELECRTRICAL CHARACTERISTICS (Continued)

V_{VADP} = 12 V, V_{VINV} = 12 V, T_a = 25 °C ± 2 °C unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
Under-Voltage Lock-Out (UVLO)							
Under-voltage lock-out	V_{UVLOR}		3.85	4.00	4.15	V	
Hysteresis on UVLO	$V_{UVLOHYS}$	Hysteresis of UVLO detection and release	0.70	0.75	0.80	V	
LED Driver							
Saturation voltage	V_{LEDSAT}	I_{out}=10mA	—	—	0.3	V	
ENB Input Voltage							
“H” input threshold	V_{IHENB}		2.6	—	—	V	
“L” input threshold	V_{ILENB}		—	—	0.6	V	
TYP1, SELLED2, NCO1, NCO2, PWR, SELFOD1, SELFOD2, SELLED1 Input Voltage							
“H” input threshold	V_{IHTYP1}		3.3	—	—	V	
“L” input threshold	V_{ILTYP1}		—	—	0.8	V	

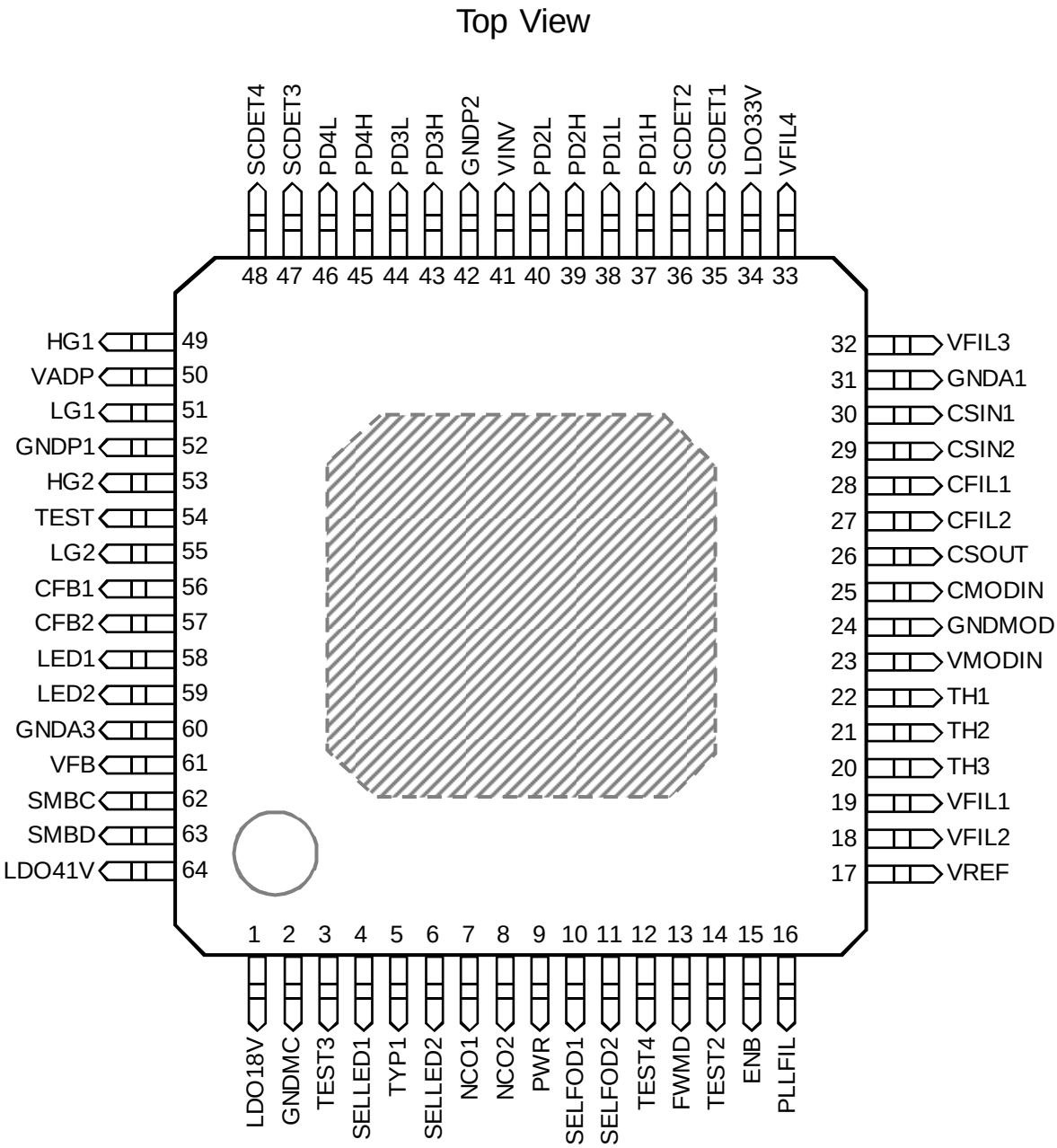
ELECRTRICAL CHARACTERISTICS (Continued)

V_{VADP} = 12 V, V_{VINV} = 12 V, T_a = 25 °C ± 2 °C unless otherwise noted.

Parameter	Symbol	Condition	Limits			Unit	Note
			Min	Typ	Max		
ASK demodulation							
Current demodulation input threshold	I_{THMOD}		—	5	—	mA	*1
Voltage demodulation input threshold	V_{THMOD}		—	50	—	mV	*1
Inverter Short-Circuit Protection (SCP)							
Detection time	V_{OCPR}	Time till oscillation stops	—	100	—	us	
Thermal Shutdown (TSD)							
Detection threshold	T_{SDR}	65 °C, with the recommended parts	—	0.648	—	V	*1
Release threshold	T_{SDF}	65 °C, with the recommended parts	—	0.727	—	V	*1
Over-Current Protection (OCP)							
Detected Current 1-1	I_{OCp11}	Type A11, R4=25mohm V_{ADP}=5V, V_{VINV}=5V Before power transfer *2	—	0.8	—	A	*1
Detected Current 1-2	I_{OCp12}	Type A11, R4=25mohm V_{ADP}=5V, V_{VINV}=5V At power transfer *3	—	3.0	—	A	*1
Detected Current 2-1	I_{OCp21}	Type A6, R4=50mohm Before power transfer *2	—	0.4	—	A	*1
Detected Current 2-2	I_{OCp22}	Type A6, R4=50mohm At power transfer *3	—	1.5	—	A	*1
Detected Current 3-1	I_{OCp31}	Type A6, High power PWR pin (No.9): LDO41V R4=50mohm Before power transfer *2	—	0.4	—	A	*1
Detected Current 3-2	I_{OCp32}	Type A6, High power PWR pin (No.9): LDO41V R4=50mohm At power transfer *3	—	1.9	—	A	*1

Note)
*1 : Designed typical values
*2: Conditions at Selection, Ping, and ID & Configuration phases. Refer to Power Transfer Phases section for more details.
*3: Conditions at Power Transfer phase. Refer to Power Transfer Phases section for more details.

Pin Layout


Top View
SCDET4 48
SCDET3 47
PD4L 46
PD4H 45
PD3L 44
PD3H 43
GNDP2 42
VINV 41
PD2L 40
PD2H 39
PD1L 38
PD1H 37
SCDET2 36
SCDET1 35
LDO33V 34
VFIL4 33
HG1 49
VADP 50
LG1 51
GNDP1 52
HG2 53
TEST 54
LG2 55
CFB1 56
CFB2 57
LED1 58
LED2 59
GNDA3 60
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SMBC 62
SMBD 63
LDO41V 64
32 VFIL3
31 GNDA1
30 CSIN1
29 CSIN2
28 CFIL1
27 CFIL2
26 CSOUT
25 CMODIN
24 GNDMOD
23 VMODIN
22 TH1
21 TH2
20 TH3
19 VFIL1
18 VFIL2
17 VREF
1 LDO18V
2 GNDMC
3 TEST3
4 SELLED1
5 TYP1
6 SELLED2
7 NCO1
8 NCO2
9 PWR
10 SELFOD1
11 SELFOD2
12 TEST4
13 FWMD
14 TEST2
15 ENB
16 PLLFIL

PIN FUNCTIONS

Pin	Name	I/O	Function	Description
1	LDO18V	Output	1.8V regulator output for MCU	Used for the internal MCU. Connect a capacitor of 1uF.
2	GNDMC	GND	Ground for MCU	
3	TEST3	Input	Test pin 3	Connect to GND. Panasonic uses this pin for test purposes only.
4	SELLED1	Input	Select LED pattern 1	Refer to “LED Indicator” in Functions section.
5	TYP1	Input	Select transmitter type 1	Refer to the Pin Settings in FUNCTIONS section.
6	SELLED2	Input	Select LED pattern 2	Refer to “LED Indicator” in Functions section.
7	NCO1	Input	Select the number of coils 1	Refer to the Pin Settings in FUNCTIONS section.
8	NCO2	Input	Select the number of coils 2	Refer to the Pin Settings in FUNCTIONS section.
9	PWR	Input	(Not used)	Connect to GND.
10	SELFOD1	Input	Select threshold value of FOD 1	Refer to the Pin Settings in FUNCTIONS section.
11	SELFOD2	Input	Select threshold value of FOD 2	Refer to the Pin Settings in FUNCTIONS section.
12	TEST4	Input	Test pin 4	Connect to GND. Panasonic uses this pin for test purposes only.
13	FWMD	Input	Test mode	Connect to GND. Panasonic uses this pin for test purposes only.
14	TEST2	Input	Test pin 2	Connect to GND. Panasonic uses this pin for test purposes only.
15	ENB	Input	System enable	Input a GND pulse for over 1ms to reset NN32251A. Normally, connect this pin to LDO33V for continuous operations. Refer to “Enable / Reset” in Functions section.
16	PLLFIL	Output	PLL loop filter	Connect a capacitor of 3900pF.
17	VREF	Output	Reference Voltage	Connect a capacitor of 4.7uF.

PIN FUNCTIONS (Continued)

Pin	Name	I/O	Function	Description
18	VFIL2	Output	Voltage detection active filter 2	Connect a capacitor of 1000pF.
19	VFIL1	Output	Voltage detection active filter 1	Connect a capacitor 2200pF.
20	TH3	Input	Thermistor voltage 3	Connect a thermistor, and place it where temperature is measured. Connect to LDO33V if a thermistor is not connected.
21	TH2	Input	Thermistor voltage 2	Connect a thermistor, and place it where temperature is measured. Connect to LDO33V if a thermistor is not connected.
22	TH1	Input	Thermistor voltage 1	Connect a thermistor, and place it where temperature is measured. Connect to LDO33V if a thermistor is not connected.
23	VMODIN	Input	ASK voltage demodulation	Input ASK voltage from Rx.
24	GNDMOD	GND	GND for demodulator	
25	CMODIN	Input	ASK current demodulation	Input ASK current from Rx
26	CSOUT	Output	Current sensor output for inverter	Connect a capacitor of 68000pF between CMODIN and this pin.
27	CFIL2	Output	Current detection active filter 2	Connect a capacitor of 1000pF.
28	CFIL1	Output	Current detection active filter 1	Connect a capacitor of 3300pF.
29	CSIN2	Input	Current detection for inverter 2	Connect a resistor of 25m ohm or 50m ohm, between CSIN1 and CSIN2.
30	CSIN1	Input	Current detection for inverter 1	
31	GNDA1	GND	GND for analog circuit 1	
32	VFIL3	Output	Voltage detection active filter 3	Connect a capacitor of 3300pF.
33	VFIL4	Output	Voltage detection active filter 4	Connect a capacitor of 1000pF.
34	LDO33V	Output	3.3V regulator output	Connect a capacitor of 1uF.
35	SCDET1	Input	Inverter short-circuit detection 1	Connect to the drain of first inverter driven from PD1H and PD1L pins.
36	SCDET2	Input	Inverter short-circuit detection 2	Connect to the drain of second inverter driven from PD2H and PD2L pins.
37	PD1H	Output	High-side gate driver of inverter 1	Connect to the gate of first inverter PMOS
38	PD1L	Output	Low-side gate driver of inverter 1	Connect to the gate of first inverter NMOS
39	PD2H	Output	High-side gate driver of inverter 2	Connect to the gate of second inverter PMOS
40	PD2L	Output	Low-side gate driver of inverter 2	Connect to the gate of second inverter NMOS

PIN FUNCTIONS (Continued)

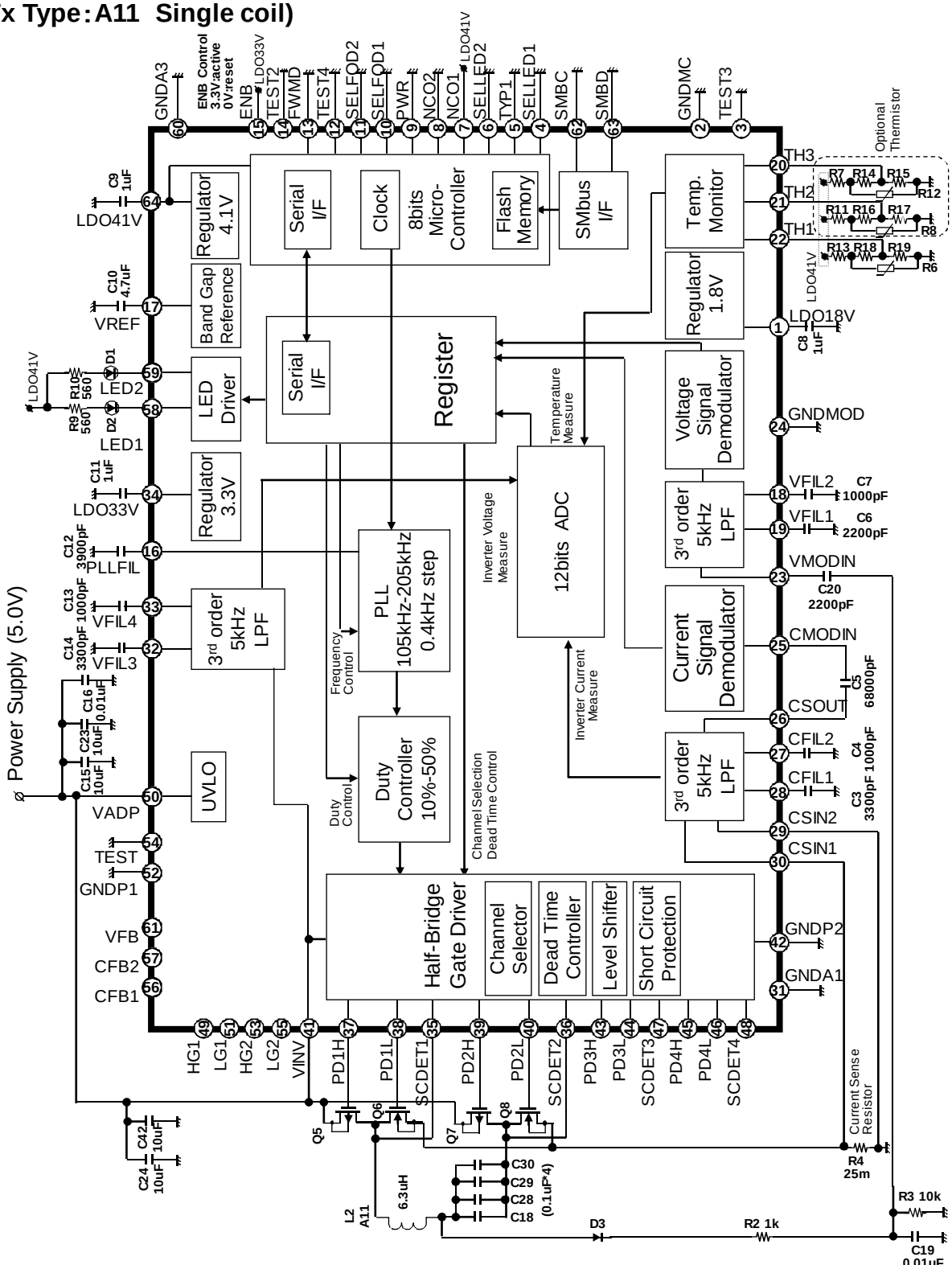
Pin	Name	I/O	Function	Description
41	VINV	Power Supply	Power for inverters	Connect to the source of PMOS of each inverter.
42	GNDP2	GND	GND for power 2	
43	PD3H	Output	High-side gate driver of inverter 3	Connect to the gate of third inverter PMOS
44	PD3L	Output	Low-side gate driver of inverter 3	Connect to the gate of third inverter NMOS
45	PD4H	Output	High-side gate driver of inverter 4	Connect to the gate of fourth inverter PMOS
46	PD4L	Output	Low-side gate driver of inverter 4	Connect to the gate of fourth inverter NMOS
47	SCDET3	Input	Short-circuit detection 3	Connect to the drain of third inverter driven from PD3H and PD3L pins.
48	SCDET4	Input	Short-circuit detection 4	Connect to the drain of fourth inverter driven from PD4H and PD4L pins.
49	HG1	Output	(Not used)	Leave this pin open
50	VADP	Power Supply	AC adapter	Input an external voltage supply of 4.6V to 19.5V.
51	LG1	Output	(Not used)	Leave this pin open
52	GNDP1	GND	GND for power 1	
53	HG2	Output	(Not used)	Leave this pin open
54	TEST	Input	Test pin	Connect to GND. Panasonic uses this pin for test purposes only.
55	LG2	Output	(Not used)	Leave this pin open
56	CFB1	Input	(Not used)	Leave this pin open
57	CFB2	Input	(Not used)	Leave this pin open
58	LED1	Output	LED driver 1	This pin is internally connected to the drain of NMOS to turn on an LED. Refer to “LED Indicator” in FUNCTIONS section for more details.
59	LED2	Output	LED driver 2	This pin is internally connected to the drain of NMOS to turn on an LED. Refer to “LED Indicator” in FUNCTIONS section for more details.

PIN FUNCTIONS (Continued)

Pin	Name	I/O	Function	Description
60	GNDA3	GND	GND for analog circuit 3	
61	VFB	Input	(Not used)	Leave this pin open
62	SMBC	Input/ Output	Clock for test mode	Connect to GND. Panasonic uses this pin for test purposes only.
63	SMBD	Input/ Output	Data for test mode	Connect to GND. Panasonic uses this pin for test purposes only.
64	LDO41V	Output	4.1V regulator output	Connect a capacitor of 1uF. LED's can be connected to this pin.

CIRCUIT DIAGRAM

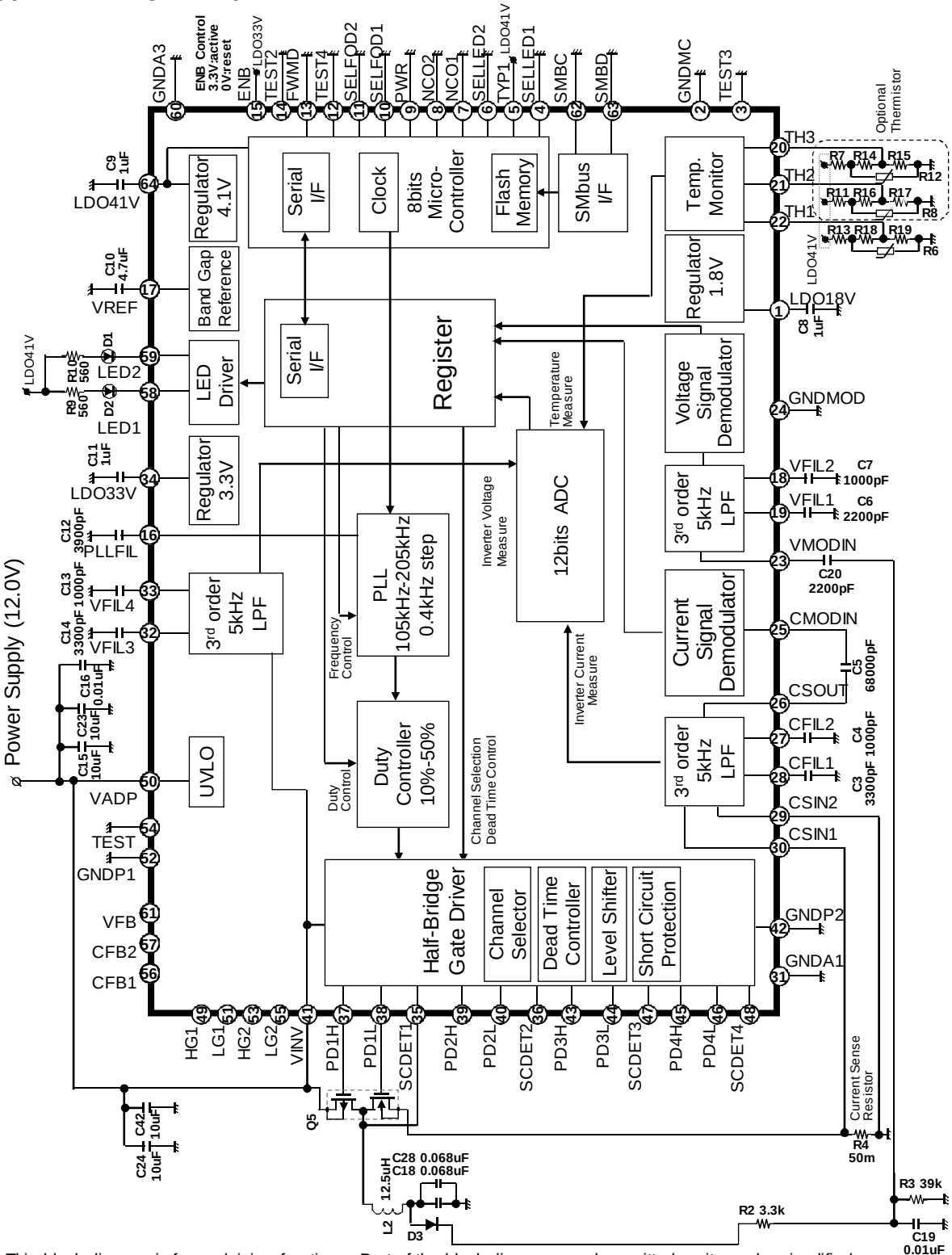
(Tx Type : A11 Single coil)



Notes) This block diagram is for explaining functions. Part of the block diagram may be omitted, or it may be simplified.

CIRCUIT DIAGRAM (Continued)

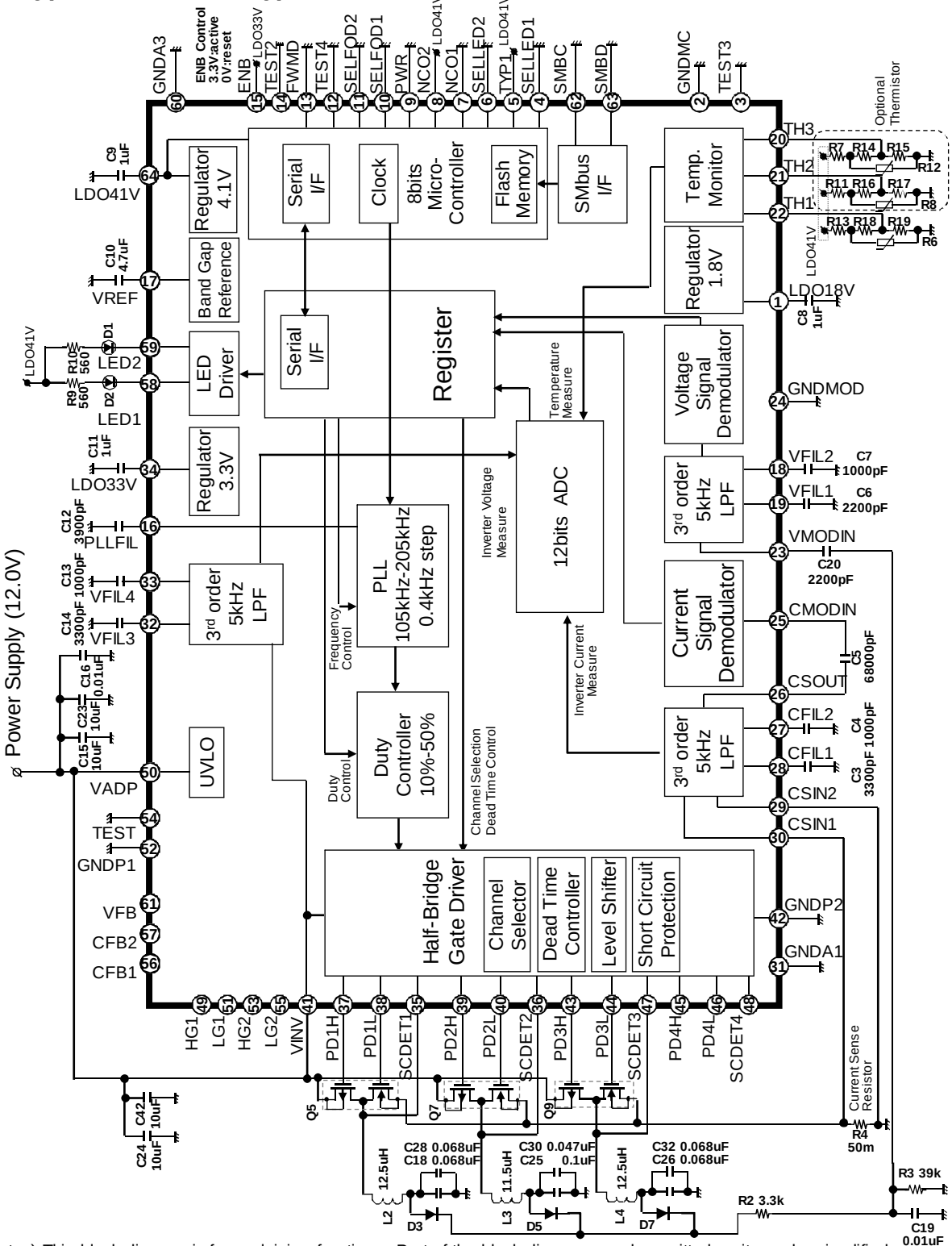
(Tx Type : A6 Single coil)



Notes) This block diagram is for explaining functions. Part of the block diagram may be omitted, or it may be simplified.

CIRCUIT DIAGRAM (Continued)

(Tx Type : A6 3-coil array)



Notes) This block diagram is for explaining functions. Part of the block diagram may be omitted, or it may be simplified.

Functions

NN32251A has the following functions.

No.	Function
1	Power Startup Condition
2	Power Transfer Phases
3	Enable / Reset
4	Power Stop and Resume Controls
5	Pin Settings
6	Transmitter Types
7	LED Indicator
8	Over Current Detection
9	Over Temperature Detection

1. Power Startup Condition

The pins VADP (No.50) and VINV (No.41) must be shorted out, because inputting VINV before VADP may result in breakage of NN32251A.
Follow the rise time of VADP and VINV as defined below.

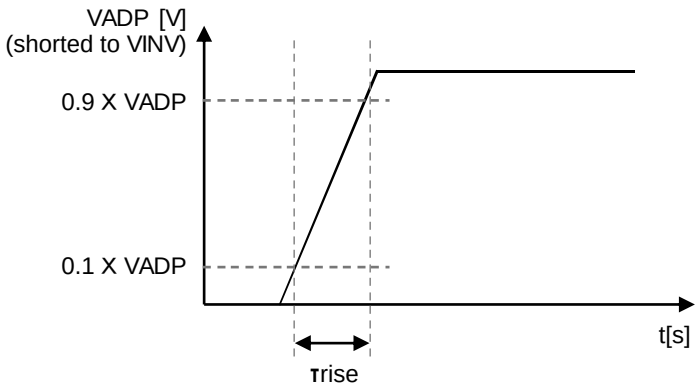


Figure A-1. Rise time characteristics of VADP

	Symbol	Condition (not tested at shipment)			unit
		min	typ	max	
Rise time	τrise	50	—	—	us

This condition is based on the circuits described in Evaluation Results followed by this chapter.
Thorough evaluation will be required if the circuit is different.

Functions (Continued)

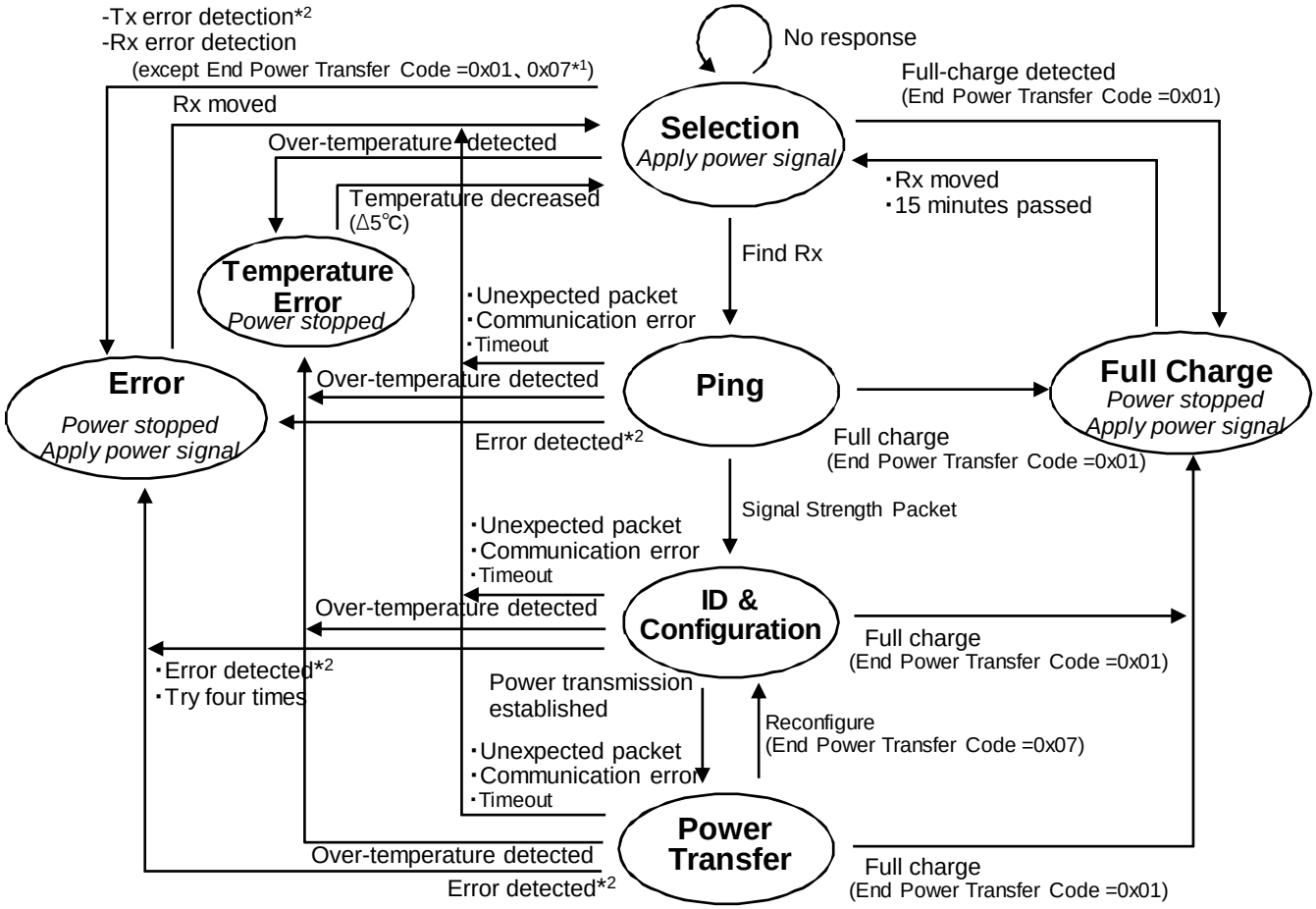
2.Power Transfer Phases

NN32251A is compliant with Qi version 1.1 of the System Description Wireless Power Transfer, Volume 1 for Low Power, defined by Wireless Power Consortium.

【At selection phase】

・VADP (Pin 50)：Input 4.6 to 19.5V

・ENB (Pin 15)：Connect LDO33V (Pin 34)



*1: The phase does not change when 0x07 is received at Selection.
*2: Errors are detected by over-current protection foreign object detection, and short-circuit protection.

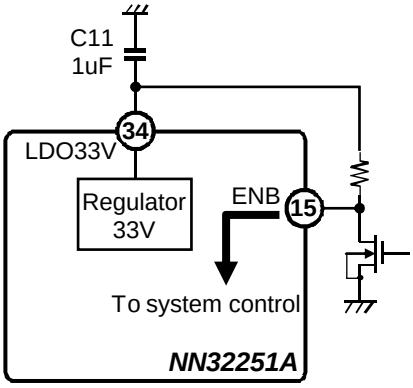
Figure A-2. State machine of power transfer phases

Functions (Continued)

3. Enable / Reset

Controlling the ENB (Pin 15) can enable, stop, or reset NN32251A. Enable will start NN32251A from the Select phase. Stop will shut down the entire system on NN32251A. Reset will enable NN32251A after sopping it.

The following figure describes the input requirements.



Condition	Input to ENB pin
Enable	LDO33V / GND
Stop	LDO33V / GND
Reset	LDO33V / GND / Over 1ms

Figure A-3. External circuit to function ENB pin.

4. Power Stop and Resume Controls

NN32251A stops power transmission due to its own protections or control from Rx. The condition to resume depends on what has stopped the power transmission.

	Power-Stop Condition	phase Transition
By Rx		
1	Full-charge detection (End Power Transfer Code =0x01)	The phase goes to Full Charge and moves to Selection by either removing the Rx or laying the Rx for over 15 minutes.
2	End Power Transfer packet of other conditions than full-charge detection	The phase goes to Error and moves to Selection by removing the Rx.
By Tx		
3	Temperature detection (Over 65℃)	The phase goes to Temperature Error and moves to Selection when temperature becomes lower than 60℃.
4	Over current protection	The phase goes to Error and moves to Selection by removing the Rx.
5	Short-circuit protection	

Functions (Continued)

5. Pin Settings

5-1. Transmitter Type

The pin TYP1 selects transmitter types defined by Wireless Power Consortium. A6 and A11 are selectable. Connect the pins as the following table shows. The pins NCO1 and NCO2 set the number of coils to use when the transmitter type of A6 is selected. The inverters must include a pair of H and L, such as PD1H and PD1L.

f number	TYP1 5	NCO2 8	NCO1 7	Number of Coils	Inverters to use	Note
Type A11 (with full bridge)						
	GND	GND	GND	1	PD1H, PD1L	FDS8958B (Dual Pch&Nch MOSFET)
	GND	GND	LDO41V			SIA445EDJ (Pch-MOSFET), SIA400EDJ (Nch-MOSFET)
	GND	LDO41V	GND			Panasonic uses these settings for test purposes only
	GND	LDO41V	LDO41V			
Type A6 (with half bridge)						
	LDO41V	GND	GND	1	PD1H, PD1L	FDS8958B (Dual Pch&Nch MOSFET)
	LDO41V	GND	LDO41V	2	PD1H, PD1L, PD2H, PD2L	
	LDO41V	LDO41V	GND	3	PD1H, PD1L, PD2H, PD2L PD3H, PD3L,	
	LDO41V	LDO41V	LDO41V	4	PD1H, PD1L, PD2H, PD2L PD3H, PD3L, PD4H, PD4L	

For the transmitter type A11, MOSFETs to use for the inverters determine FOD characteristics of NN32251A. Therefore, pin settings depend on the device as depicted above.

Functions (Continued)

5. Pin Settings (Continued)

5-2. FOD Threshold

Threshold level of the foreign object protection, defined in WPC Ver.1.1, can be adjusted by pins SELFOD1(No.10) and SELFOD2(No.11) as the next table depicts.

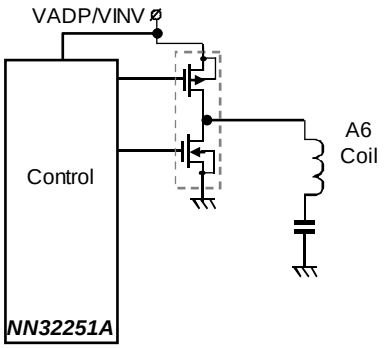
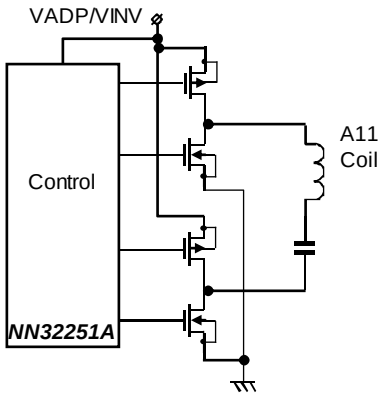
Pin Name	SELFOD2	SELFOD1	FOD Threshold
Pin Number	11	10	
	GND	GND	Default value
	GND	LDO41V	Offset by -100mW from default value
	LDO41V	GND	Offset by +100mW from default value
	LDO41V	LDO41V	Offset by +200mW from default value

The FOD value will likely depend the coil and its drivers to be used. Consult with Panasonic support for more details.

Functions (Continued)

6.Transmitter Types

NN32251A supports the transmitter types of A6 and A11defined in Qi version 1.1 of the System Description Wireless Power Transfer, Volume 1 for Low Power. The following table shows the detailed specification.

Tx Type	A6			A11		
Number of coils	One or more			Single		
Alignment aid	free			・A marked Interface Surface ・A visual feedback display ・An audible or haptic feedback		
Modulation Method	Frequency or duty			Frequency or duty		
Operating Frequency (fop)	Min	initial	max	Min	initial	max
	115kHz	175kHz	205kHz	110kHz	175kHz	205kHz
resolution	0.01×fop - 0.7kHz (115…175kHz) 0.015×fop - 1.58kHz (175…205kHz)			0.01×fop - 0.7kHz (115…175kHz) 0.015×fop - 1.58kHz (175…205kHz)		
Duty cycle	10%	50%	50%	10%	50%	50%
resolution	0.1%			0.1%		
Inverter Voltage	12±5%V			5±5%V		
Configuration	Half-bridge			Full-bridge		
	 ※NN32251A has 4 inverters to drive up to 4 coils.					

Find more detailed description from WPC homepage.
URL: http://www.wirelesspowerconsortium.com/

Functions (Continued)

7. LED Indicator

NN32251A controls two LED's, and the following colors are recommended to be used.

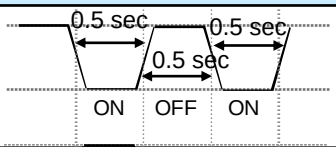
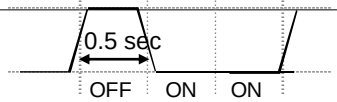
Pin Name	**LED1**	**LED2**
Number	No.58	No.59
LED Color	Red	Green

Combination of LED display can be adjusted by pins SELLED1(No.4) and SELLED2(No.6) as the next table shows.

Pin Name (Number)		LED Pin	**System Status**			
			Selection	Ping ID & Configuration Power Transfer	Full Charge	Error Temperature Error
			Charge			
SELLED2 (No.6)	SELLED1 (No.4)		Standby	Charge	Full Charge	Error
GND	GND	LED1	OFF	ON	OFF	Blink*1
		LED2	OFF	OFF	ON	OFF
GND	LDO41V	LED1	OFF	OFF	OFF	ON
		LED2	OFF	Blink*1	ON	OFF
LDO41V	GND	LED1	ON	OFF	OFF	ON
		LED2	ON	Blink*1	ON	OFF
LDO41V	LDO41V	LED1	OFF	OFF	OFF	ON
		LED2	OFF	ON	OFF	OFF

*1 Blinking frequency = 0.625Hz

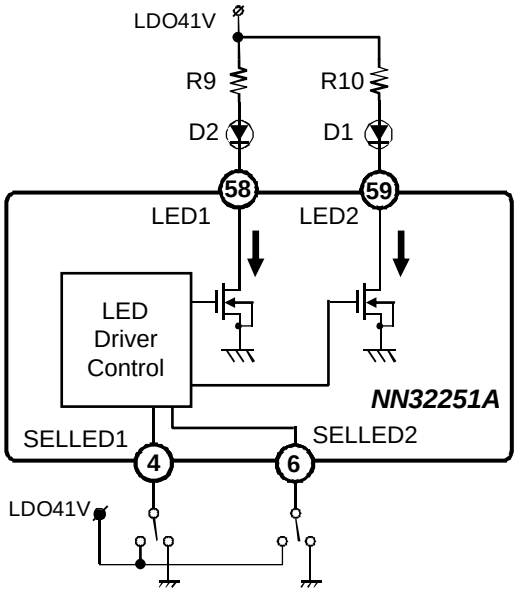
The LED display pattern when the power is provided from AC adapter is shown below.

Power On form AC adaptor	
Pin	**LED display**
LED1 (RED)	
LED2 (Green)	

When the supply voltage decreases, by such reasons as not-enough current from an AC adaptor, the LED pattern in charge status starts and goes back to the above power-on sequence, and then it repeats.

Functions (Continued)

7. LED Indicator (Continued)



LED	Driver Control
ON	Low (ON)
OFF	High (OFF)
Blink	1.6 sec / 0.8 sec

Figure A-4. LED Circuit Diagram

* LDO41V must be used for the LED power source for proper operation.

8.Over Current Detection

Current is monitored at inverters to detect over-current. A sense resistor must be connected between pins CSIN1and CSIN2. The resistance value is 25mΩfor the transmitter type of A6 or 50mΩ for the transmitter type of A11.

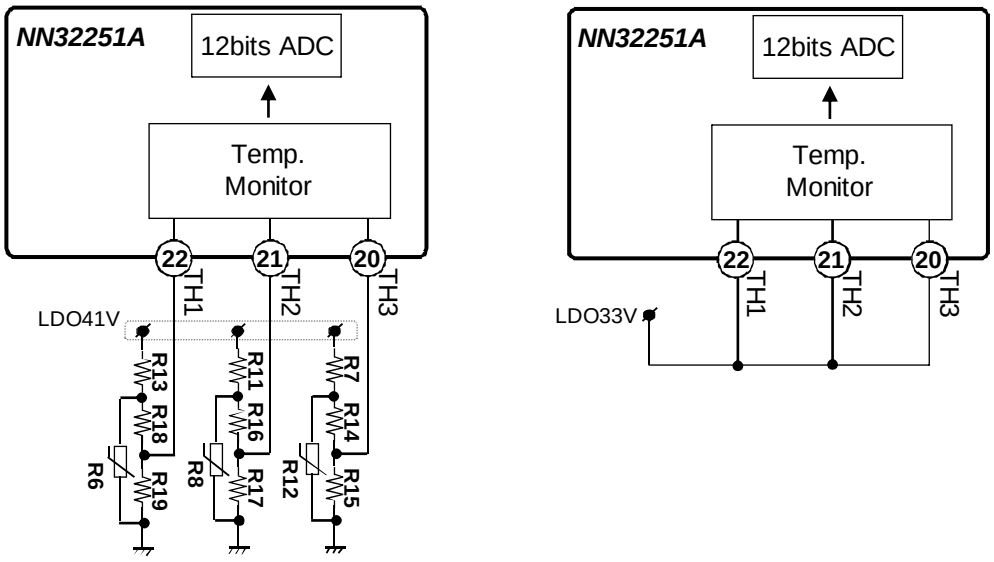
The current limit is defined depending on the power transfer phase as well as the transmitter type as shown in the next table. The exact value may vary due to variance of the external resistor.

Type	Over Current Value	
	Selection / Ping / ID & Configuration Phase	Power Transfer Phase
A6	0.4A	1.5A
A11	0.8A	3.0A

Functions (Continued)

9. Over Temperature Protection

NN32251A has three pins (TH1, TH2, and TH3) to connect thermistors.
A thermistor (NXRT15XH103FA3A016 recommended) is inserted into R6, R8, or R12, and the detecting temperatures are adjusted by the values of remaining resistors. Power transfer stops when a temperature becomes over a specified value.
For example, when NXRT15XH103FA3A016 is used for the pin TH1, and power transfer needs to be stopped over 65 ℃ and restarted under 60 ℃ (with ±2℃ accuracy), the following resistor values may be used; R13: 10kohm±1%, R18: 10kohm±1%, and R19: 38.3kohm±1%.
The detecting voltages, then, will be 0.641V for stopping power transfer and 0.719V for restarting it.
In order to inactivate this function, connect the pins TH1, TH2, and TH3 to LDO33V.



(a) Active circuit **(b) The function is inactivated**

図A-5. Over-Temperature Detection

EVALUATION RESULTS

Evaluation Circuit Diagram 1

Conditions :

Tx Type: A11, Single coil
ADP (Pin 50): 5V input
ENB (Pin 15): Connected to LDO33V
TYP1(Pin 5) : Connected to GND
Rx: AN32258A evaluation board

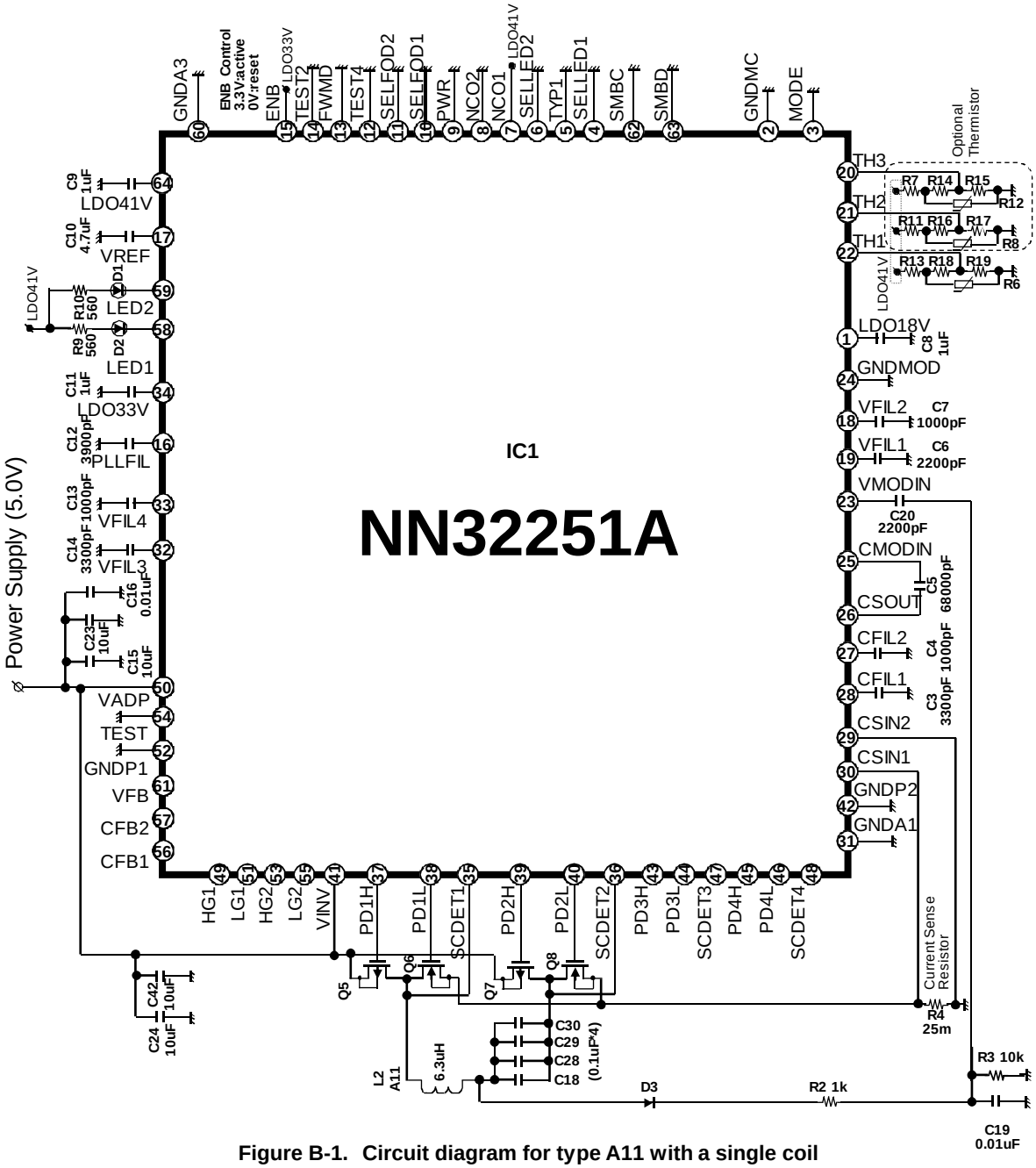


Figure B-1. Circuit diagram for type A11 with a single coil

TYPICAL CHARACTERISTICS

1. Power Efficiency [Type A11]

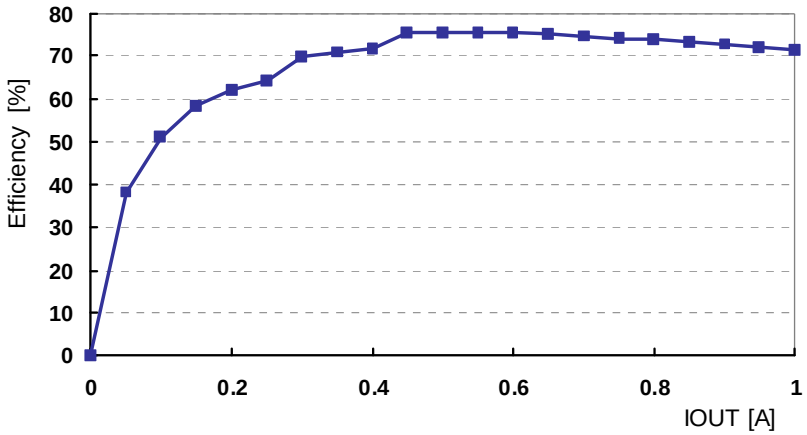


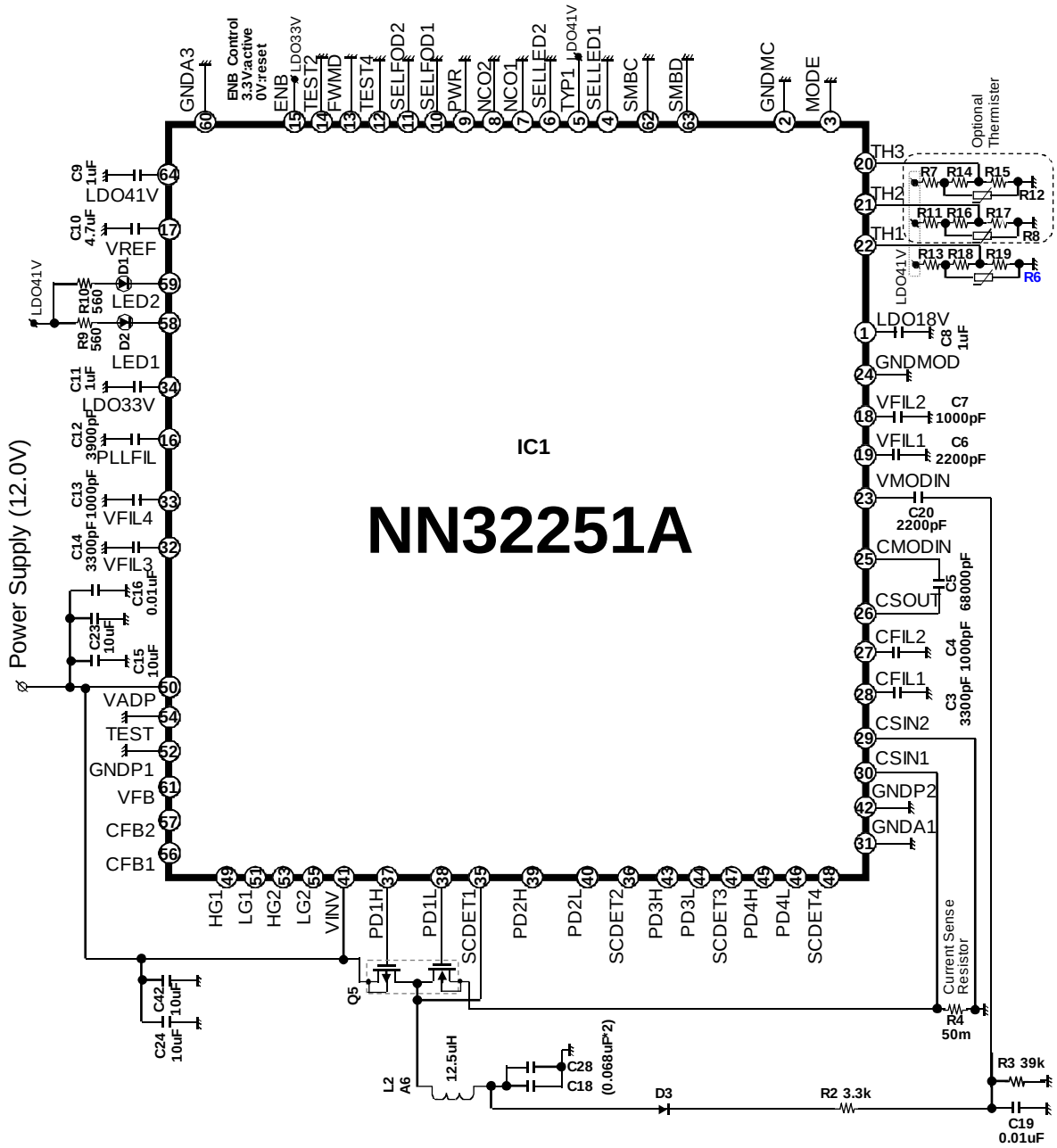
Figure B-2. Power Efficiency with Transmitter Type A11

EVALUATION RESULTS

Evaluation Circuit Diagram 2

Conditions :

Tx Type: A6, Single coil
ADP (Pin 50): 12V input
ENB (Pin 15): Connected to LDO33V
TYP1(Pin 5): Connected to LDO41V
Rx: AN32258A evaluation board



図B-3. Circuit diagram for high power (type A6 with a single coil

TYPICAL CHARACTERISTICS

2. Power Efficiency [Type A6]

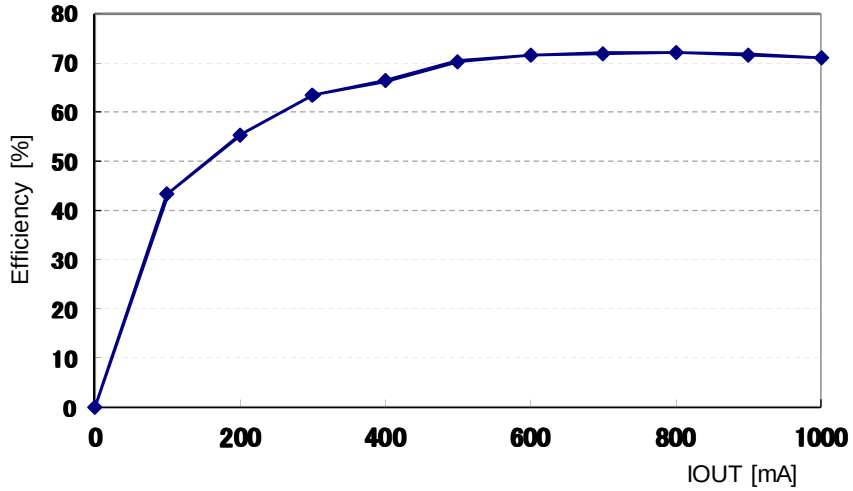
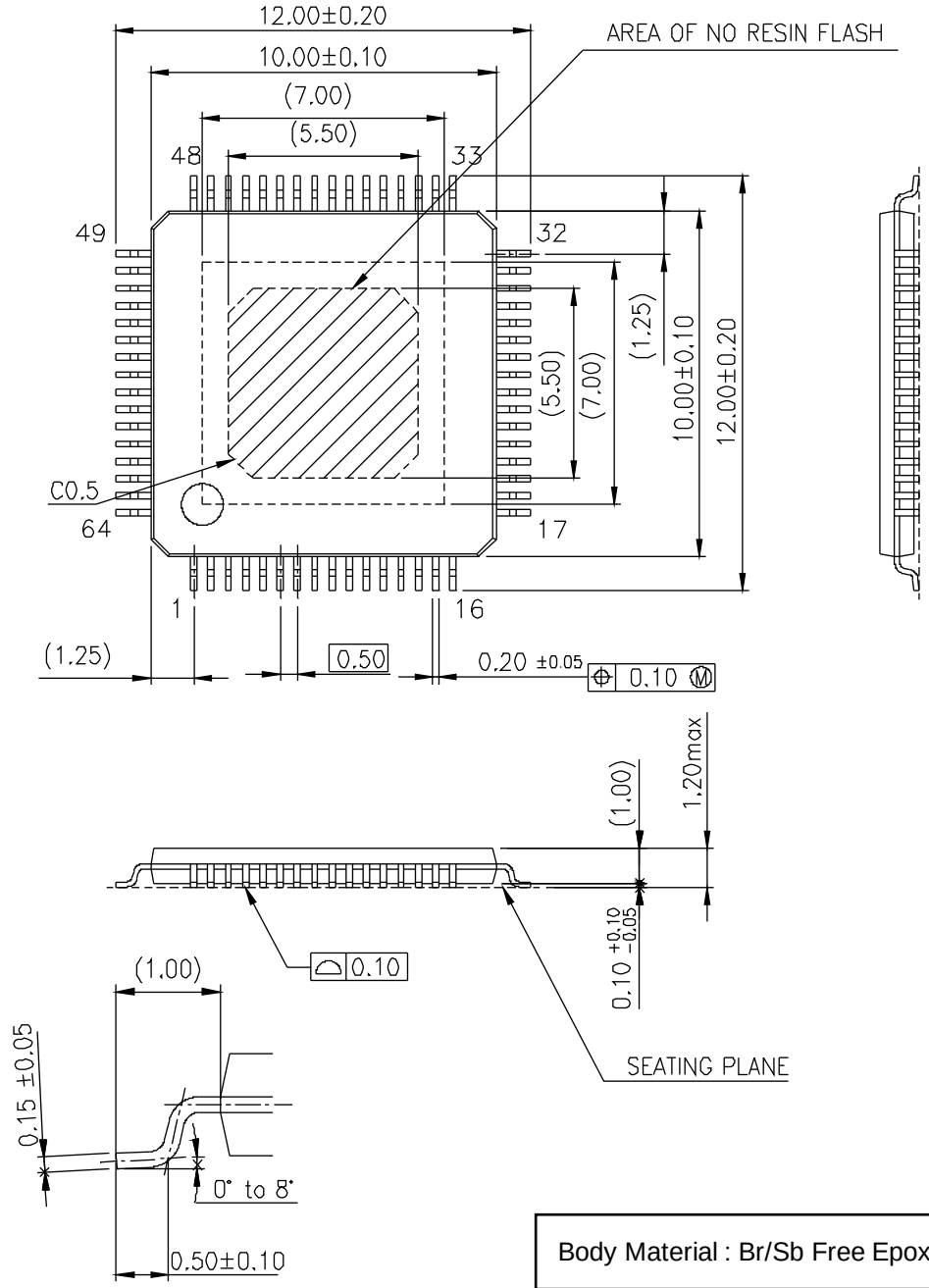


Figure B-4. Power Efficiency with AN32258A, High Power, and Transmitter Type A6

PACKAGE INFORMATION

Package Code : HQFP064-P-1010C

Unit:mm



Body Material : Br/Sb Free Epoxy Resin
Lead Material : Cu Alloy
Lead Finish Method : Pd Plating

IMPORTANT NOTICE

1. When using the IC for new models, verify the safety including the long-term reliability for each product.
2. When the application system is designed by using this IC, please confirm the notes in this book.
   Please read the notes to descriptions and the usage notes in the book.
3. This IC is intended to be used for general electronic equipment.
   Consult our sales staff in advance for information on the following applications: Special applications in which exceptional quality and reliability are required, or if the failure or malfunction of this IC may directly jeopardize life or harm the human body.
   Any applications other than the standard applications intended.
   (1) Space appliance (such as artificial satellite, and rocket)
   (2) Traffic control equipment (such as for automotive, airplane, train, and ship)
   (3) Medical equipment for life support
   (4) Submarine transponder
   (5) Control equipment for power plant
   (6) Disaster prevention and security device
   (7) Weapon
   (8) Others : Applications of which reliability equivalent to (1) to (7) is required
   Our company shall not be held responsible for any damage incurred as a result of or in connection with the IC being used for any special application, unless our company agrees to the use of such special application.
   However, for the IC which we designate as products for automotive use, it is possible to be used for automotive.
4. This IC is neither designed nor intended for use in automotive applications or environments unless the IC is designated by our company to be used in automotive applications.
   Our company shall not be held responsible for any damage incurred by customers or any third party as a result of or in connection with the IC being used in automotive application, unless our company agrees to such application in this book.
5. Please use this IC in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Our company shall not be held responsible for any damage incurred as a result of our IC being used by our customers, not complying with the applicable laws and regulations.
6. Pay attention to the direction of the IC. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might be damaged.
7. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
8. Perform visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as solder-bridge between the pins of the IC. Also, perform full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the IC during transportation.
9. Take notice in the use of this IC that it might be damaged when an abnormal state occurs such as output pin-VCC short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short). Safety measures such as installation of fuses are recommended because the extent of the above-mentioned damage will depend on the current capability of the power supply.
10. The protection circuit is for maintaining safety against abnormal operation. Therefore, the protection circuit should not work during normal operation.
    Especially for the thermal protection circuit, if the area of safe operation or the absolute maximum rating is momentarily exceeded due to output pin to VCC short (Power supply fault), or output pin to GND short (Ground fault), the IC might be damaged before the thermal protection circuit could operate.
11. Unless specified in the product specifications, make sure that negative voltage or excessive voltage are not applied to the pins because the IC might be damaged, which could happen due to negative voltage or excessive voltage generated during the ON and OFF timing when the inductive load of a motor coil or actuator coils of optical pick-up is being driven.
12. Verify the risks which might be caused by the malfunctions of external components.

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