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NTE7224
Integrated Circuit
Quasi–Resonant Topology Primary Switching Regulator

Description:

The NTE7224 is a quasi–resonant topology integrated circuit in a 7–Lead TO220 type package designed for SMPS applications. This device shows lower EMI noise characteristics than conventional PWM solutions, especially at greater than 2MHz. It also provides a soft–switching operation to turn on the internal MOSFET at close to zero voltage (V_{DS} bottom point) by use of the resonant characteristic of primary inductance and a resonant capacitor.

The package is a fully molded TO220, which contains the controller chip (MIC) and MOSFET, enabling output power up to 160W with a $120V_{AC}$ input. The bottom–skip function skips the first bottom of V_{DS} and turns on the MOSFET at the second bottom point, to minimize an increase of operational frequency at light output load, improving system–level efficiency over the entire load range.

There are two standby functions available to reduce the input power under very light load conditions. The first is an auto–burst mode operation that is internally triggered by periodic sensing, and the other is a manual standby mode, which is executed by clamping the secondary output. In general applications, the manual standby mode reduces the input power further compared to the auto–burst mode.

The soft–start function minimizes surge voltage and reduces power stress to the MOSFET and to the secondary rectifying diodes during the start–up sequence. Various protections such as overvoltage, overload, overcurrent, maximum on–time protections and avalanche–energy–guaranteed MOSFET secure good system–level reliability.

Features:

- Quasi–Resonant Topology IC ⇒ Low EMI Noise and Soft Switching
- Bottom–Skip Operation ⇒ Improved System Efficiency Over the Entire Output Load by Avoiding Increase of Switching Frequency
- Standby Burst Mode Operation ⇒ Lowers Input Power at Very Light Output Load Conditions
- Avalanche–Guaranteed MOSFET ⇒ Improves System–Level Reliability and Does Not Require V_{DSS} derating
- 500V / 0.57Ω, 160W ($120V_{AC}$ Input)
- Various Protections ⇒ Improved System–Level Reliability
  - Pulse–By–Pulse Drain Overcurrent Limiting
  - Overvoltage Protection (Bias Winding Voltage Sensing), with Latch
  - Overload Protection with Latch
  - Maximum On–Time Limit

Applications:

- Set Top Box
- LCD PC Monitor, LCD TV
- Printer, Scanner
- SMPS Power Supplies

Absolute Maximum Ratings: (T_A = +25°C, Note 1 unless otherwise specified)

Drain Current (Single Pulse, Pin1−Pin3), $I_D$peak 20A
Maximum Switching Current (T_A = −20° to +125°C, Pin1−Pin3, Note 2), $I_D$max 20A
Single Pulse Avalanche Energy, E_{SA}
(Single Pulse, V_{DD} = 99V, L = 20mH, $I_L$peak = 5.8A, Pin1−Pin3) 380mJ
Input Voltage for Controller [MIC] (Pin4−Pin3), V_{CC} 35V
SS/OLP Terminal Inflow Current (Pin6−Pin3), V_{SSOLP} . . . . . −0.5 to 6.0V
FB Terminal Inflow Current (Pin6−Pin3), I_{FB} 10mA
FB Terminal Voltage (I_{FB} within the limits of I_{FB}, Pin6−Pin3), V_{FB} . . . . . −0.5 to 9.0V
OCP/BD Terminal Voltage (Pin7−Pin3), V_{OCPBD} . . . . . −1.5 to 5.0V
MOSFET Power Dissipation (Pin1−Pin3), P_{D1}
With infinite heatsink 28.7W
Without heatsink 1.3W
Controller [MIC] Power Dissipation (V_{CC} * I_{CC}, Pin4−Pin3), P_{D2} 0.8W
Junction Temperature, T_J . . . . . +150°C
Operating Internal Leadframe Temperature range (Refer to T_{OP}), T_F . . . . . −20° to +115°C
Operating Ambient Temperature Range, T_{OP} . . . . . −20° to +115°C
Storage Temperature Range, T_{stg} . . . . . −40° to +125°C

Note 1. All performance characteristics given are typical values for circuit or system baseline design only and are at the nominal operating voltage and ambient temperature of +25°C, unless otherwise stated.

Note 2. $I_D$max is the drain current determined by the drive voltage of the IC and the threshold voltage, V_{th}, of the MOSFET.

Electrical Characteristics:

Parameter	Symbol	Terminals	Min	Typ	Max	Unit
Electrical Characteristics for Controller (MIC) V_{CC} = 20V, T_A = +25°C, Note 3 unless otherwise specified						
Power Supply Start−Up Operation						
Operation Start Voltage	$V_{CC(ON)}$	Pin4 – Pin3	16.3	18.2	19.9	V
Operation Stop Voltage	$V_{CC(OFF)}$	Pin4 – Pin3	8.8	9.7	10.6	V
Circuit Current In Operation	$I_{CC(ON)}$	Pin4 – Pin3	–	–	6	mA
Circuit Current In Non−Operation	$I_{CC(OFF)}$	Pin4 – Pin3	–	–	100	µA
Oscillation Frequency	f_{OSC}	Pin1 – Pin3	19	22	25	kHz
Soft Start Operation Stop Voltage	$V_{SSOLP(SS)}$	Pin5 – Pin3	1.1	1.2	1.4	V
Soft Start Operation Charging Current	$I_{SSOLP(SS)}$	Pin5 – Pin3	–710	–550	–390	µA
Normal Operation						
Bottom−Skip Operation Threshold Voltage 1	$V_{OCPBD(BS1)}$	Pin7 – Pin3	–0.720	–0.665	–0.605	V
Bottom−Skip Operation Threshold Voltage 2	$V_{OCPBD(BS2)}$	Pin7 – Pin3	–0.485	–0.435	–0.385	V
Overcurrent Detection Threshold Voltage	$V_{OCPBD(LIM)}$	Pin7 – Pin3	–0.995	–0.940	–0.895	V
OCP/BDOCP/BD Terminal Outflow Current	I_{OCPBD}	Pin7 – Pin3	–250	–100	–40	µA
Quasi−Resonant Operation Threshold Voltage 1	$V_{OCPBD(TH1)}$	Pin7 – Pin3	0.28	0.40	0.52	V
Quasi−Resonant Operation Threshold Voltage 2	$V_{OCPBD(TH2)}$	Pin7 – Pin3	0.67	0.80	0.93	V
FB Terminal Threshold Voltage	$V_{FB(OFF)}$	Pin6 – Pin3	1.32	1.45	1.58	V
FB terminal Inflow Current (Normal Operation)	$I_{FB(ON)}$	Pin6 – Pin3	600	1000	1400	µA

Note 3. Current polarity with respect to the IC: positive current indicates current sink at the terminal named, negative current indicates source at the terminal named.

Electrical Characteristics (Cont'd):

Parameter	Symbol	Terminals	Min	Typ	Max	Unit
Electrical Characteristics (Cont'd) for Controller (MIC) V_{CC} = 20V, T_A = +25°C, Note 3 unless otherwise specified						
Standby Operation						
Standby Operation Start Voltage	$V_{CC(S)}$	Pin4 – Pin3	10.3	11.1	12.7	V
Standby Operation Start Voltage Interval	$V_{CC(SK)}$	Pin4 – Pin3	1.10	1.35	1.75	V
Standby Non–Operation Circuit Current	$I_{CC(S)}$	Pin4 – Pin3	–	20	56	μA
FB Terminal Inflow Current, Standby Operation	$I_{FB(S)}$	Pin6 – Pin3	–	4	14	μA
FB Terminal Threshold Voltage, Standby Operation	$V_{FB(S)}$	Pin6 – Pin3	0.55	1.10	1.50	V
Minimum On Time	$I_{ON(MIN)}$	Pin1 – Pin3	–	0.75	1.20	μs
Maximum On Time	$I_{ON(MAX)}$	Pin1 – Pin3	27.5	32.5	39.0	μs
Protection Operation						
Overload Protection Operation Threshold Voltage	$V_{SSOLP(OLP)}$	Pin5 – Pin3	4.0	4.9	5.8	V
Overload Protection Operation Charging Current	$I_{SSOLP(OLP)}$	Pin5 – Pin3	–16	–11	–6	μA
Overvoltage Protection Operation Voltage	$V_{CC(OVP)}$	Pin4 – Pin3	25.5	27.7	29.9	V
Latch Circuit Holding Current (Note 4)	$I_{CC(H)}$	Pin4 – Pin3	–	45	140	μA
Latch Circuit Release Voltage (Note 4)	$V_{CC(La.OFF)}$	Pin4 – Pin3	6.0	7.2	8.5	V
Electrical Characteristics for MOSFET T_A = +25°C unless otherwise specified						
Drain–to–Source Breakdown Voltage	V_{DSS}	Pin1 – Pin3	500	–	–	V
Drain Leakage Current	I_{DSS}	Pin1 – Pin3	–	–	300	μA
On Resistance	$R_{DS(on)}$	Pin1 – Pin3	–	–	0.57	Ω
Switching Time	t_f	Pin1 – Pin3	–	–	400	ns
Thermal Resistance	R_{thJA}	Junction to Internal Frame	–	–	1.55	°C/W

Note 3. Current polarity with respect to the IC: positive current indicates current sink at the terminal named, negative current indicates source at the terminal named.

Note 4. Latch circuit refers to operation during Overload Protection or Overvoltage Protection.

Electrical Characteristics: (Test Conditions, Note 5)

Parameter	Test Conditions	V_{CC} (V)
Operation Start Voltage	V_{CC} voltage at which oscillation starts.	0 → 20
Operation Stop Voltage	V_{CC} voltage at which oscillation stops.	20 → 8.8
Circuit Current In Operation	Inflow current flowing into power supply terminal in oscillation.	20
Circuit Current In Non–Operation	Inflow current flowing into power supply terminal prior to oscillation.	15
Oscillation Frequency	Oscillation frequency (f_{OSC} = 1 / T).	20
Soft Start Operation Stop Voltage	SS/OLP terminal voltage at which ISS/OLP reach ≥–100μA by raising the SS/OLP terminal voltage from 0V gradually.	20
Soft Start Operation Charging Current	SS/OLP terminal charging current (SS/OLP terminal voltage = 0V).	20
Bottom–Skip Operation Threshold Voltage 1	Input 1 μs pulse width to OCP/BD terminal twice after V_{1-3} rises. After that, offset the input waveform gradually from 0V in the minus direction. Measurement of the offset voltage $V_{OCPBD(BS1)}$ is taken when the V_{1-3} start–to–fall point switches from two–pulses–after to one–pulse–after.	20
Bottom–Skip Operation Threshold Voltage 2	After measuring $V_{OCPBD(BS1)}$, offset the input waveform gradually. Measurement of the offset voltage $V_{OCPBD(BS2)}$ is taken when the V_{1-3} start–to–fall point switches from two–pulses–after to one–pulse–after.	20

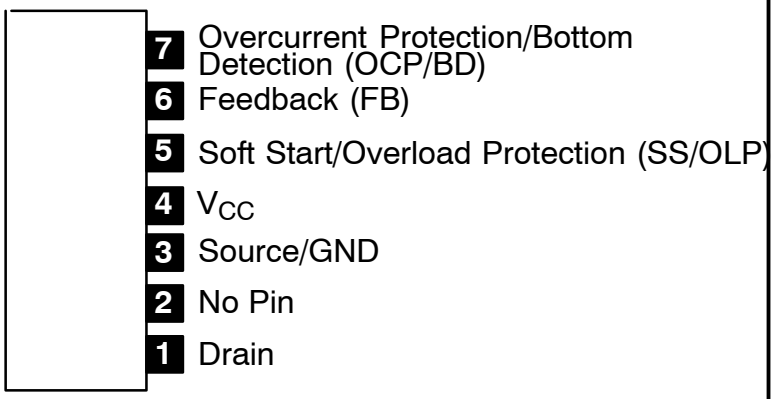
Note 5. Oscillating operation is specified with a rectangular waveform between Pin1 and Pin3.

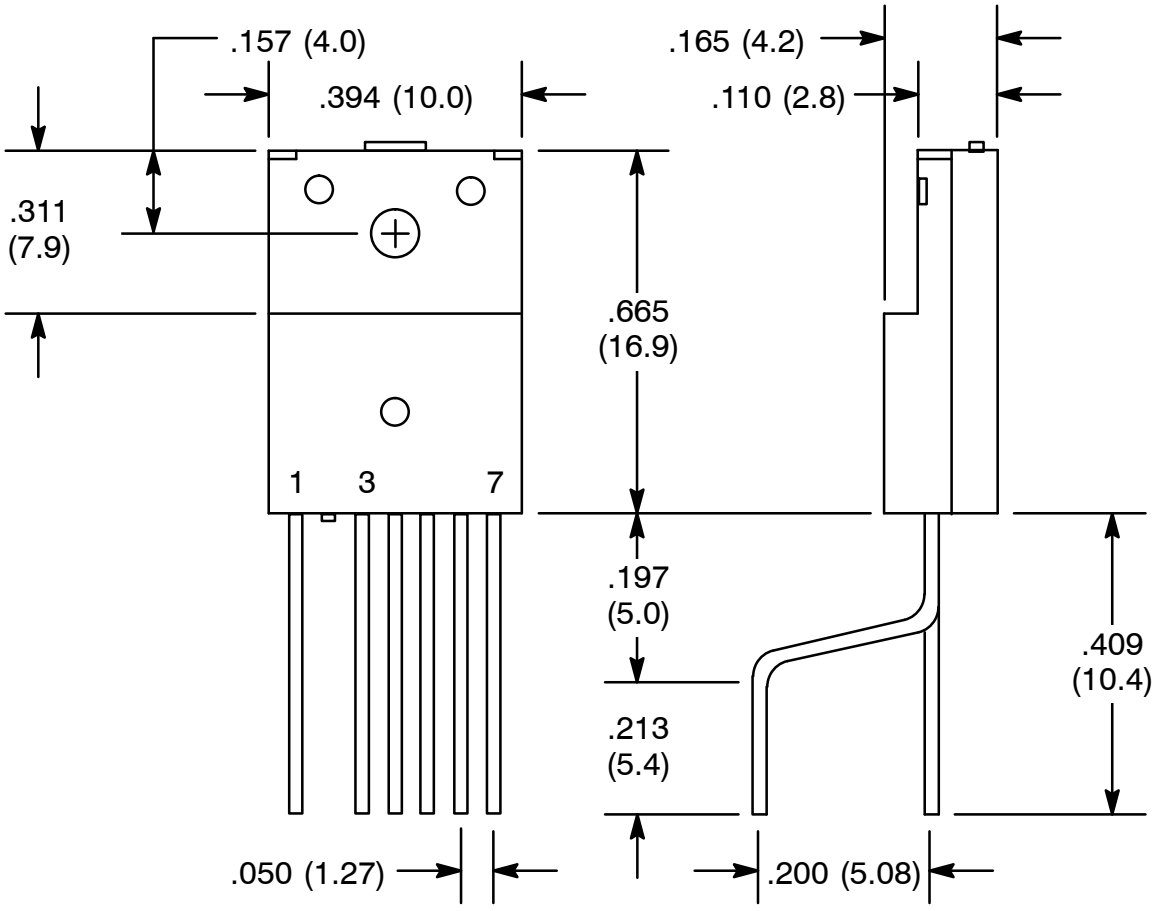
Electrical Characteristics (Cont'd): (Test Conditions, Note 5)

Parameter	Test Conditions	V_{CC} (V)
Overcurrent Detection Threshold Voltage	OCP/BD terminal voltage at which oscillation stops by lowering the OCP/BD terminal voltage from 0V gradually.	20
Quasi-Resonant Operation Threshold Voltage 1	OCP/BD terminal voltage at which oscillation starts with setting the OCP/BD terminal voltage at 1V, and then lowering the voltage gradually.	20
Quasi-Resonant Operation Threshold Voltage 2	OCP/BD terminal voltage at which oscillation stops by raising the OCP/BD terminal voltage from 0V gradually.	20
FB Terminal Threshold Voltage	FB terminal voltage at which oscillation stops by raising the FB terminal voltage from 0V gradually.	20
FB Terminal Inflow Current (Normal Operation)	FB terminal inflow current (FB terminal voltage = 1.6V).	20
Standby Operation Start Voltage	V_{CC} voltage at which I_{CC} reaches ≥1mA (FB terminal voltage = 1.6V).	0 → 15
Standby Operation Start Voltage Interval	Specified by $V_{CC(S)} - V_{CC(OFF)}$.	–
Standby Non–Operation Circuit Current	Inflow current flowing into power supply terminals prior to oscillation (FB terminal voltage = 1.6V).	10.2
FB Terminal Inflow Current, Standby Operation	FB terminal inflow current (FB terminal voltage = 1.6V).	10.2
FB Terminal Threshold Voltage Standby Operation	FB terminal voltage at which oscillation starts by raising the FB terminal voltage from 0V gradually.	15
Minimum On Time	Waveform between terminals 1 and 3 at low.	20
Maximum On Time	Waveform between terminals 1 nd 3 at low.	20
Overload Protection Operation Threshold Voltage	SS/OLP terminal voltage at which oscillation stops.	20
Overload Protection Operation Charging Current	SS/OLP terminal charging current (SS/OLP terminal voltage = 2.5V).	–
Overvoltage Protection Operation Voltage	V_{CC} voltage at which oscillation stops.	0 → 30
Latch Circuit Holding Current	Inflow current at $V_{CC(OFF)} - 0.3$; after OVP operation.	$V_{CC(OFF)} - 0.3$
Latch Circuit Release Voltage	V_{CC} voltage at which I_{CC} reaches 20μA or lower by decreasing V_{CC} after OVP operation.	30 → 6

Note 5. Oscillating operation is specified with a rectangular waveform between Pin1 and Pin3.

Pin Connection Diagram
(Front View)

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.165 (4.2)
.110 (2.8)
.311
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.665
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1
3
7
.197
(5.0)
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(5.4)
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(10.4)
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