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## **NTE1786 Integrated Circuit Frequency Lock Loop (FLL) Tuning & Control Circuit**

**Description:**

The NTE1786 is an integrated circuit in a 24-Lead DIP type package that provides closed-loop digital tuning of TV receivers, with or without AFC, as required. This device also controls up to 4 analog functions, 4 general purpose I/O ports and 4 high-current outputs for tuner band selection.

**Features:**

- Combined Analog and Digital Circuitry Minimizes the Number of Additional Interfacing Components Required
- Frequency Measurement with Resolution of 50kHz
- Selectable Prescaler Divisor of 64 or 256
- 32V Tuning Voltage Amplifier
- 4 High-Current Outputs for Direct Band Selection
- 4 Static Digital-to-Analog Convertors (DACs) for Control of Analog Functions
- 4 General Purpose Input/Output (I/O) Ports
- Tuning with Control of Speed and Direction
- Tuning with or without AFC
- Single-Pin, 4MHz On-Chip Oscillator
- I<sup>2</sup>C Bus Slave Transceiver

**Applications:**

- TV Receivers
- Satellite Receivers
- CATV Converters

**Absolute Maximum Ratings:**

Supply Voltage Ranges,

Pin13, V <sub>CC1</sub> .....	-0.3 to +18V
Pin19, V <sub>CC2</sub> .....	-0.3 to +18V
Pin14, V <sub>CC3</sub> .....	-0.3 to +36V

**Absolute Maximum Ratings (Cont'd):**

Input/Output Voltage Ranges,

Pin2, $V_{SDA}$ .....	-0.3 to +18V
Pin3, $V_{SCL}$ .....	-0.3 to +18V
Pin4 to Pin7, $V_{P2X}$ .....	-0.3 to +18V
Pin8 & Pin9 (Note 1), $V_{AFC+}$ , $V_{AFC-}$ .....	-0.3 to $V_{CC1}$
Pin10, $V_{TI}$ .....	-0.3 to $V_{CC1}$
Pin12 (Note 2), $V_{TUN}$ .....	-0.3 to $V_{CC3}$
Pin15 to Pin18 (Note 2), $V_{P1X}$ .....	-0.3 to $V_{CC2}$
Pin20 (Note 1), $V_{FDIV}$ .....	-0.3 to $V_{CC1}$
Pin21, $V_{OSC}$ .....	-0.3 to +5V
Pin1, Pin22 to Pin24 (Note 1), $V_{DACX}$ .....	-0.3 to $V_{CC1}$

Total Power Dissipation,  $P_{TOT}$  ..... 1000mW

Operating Ambient Temperature Range,  $T_A$  ..... -20° to +70°C

Storage Temperature Range,  $T_{stg}$  ..... -65° to +150°C

Note 1. Pin voltage may exceed supply voltage if current is limited to 10mA.

Note 2. Pin voltage must not exceed 18v but may exceed  $V_{CC2}$  if current is limited to 200mA.

**DC and AC Electrical Characteristics:** ( $T_A = +25^\circ\text{C}$ ,  $V_{CC1}$ ,  $V_{CC2}$ ,  $V_{CC3}$  at typical voltages unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage	$V_{CC1}$		10.5	12.0	13.5	V
	$V_{CC2}$		4.7	13.0	16.0	V
	$V_{CC3}$		30	32	35	V
Supply Current (No Outputs Loaded)	$I_{CC1}$		18	30	45	mA
	$I_{CC2}$		0	-	0.1	mA
	$I_{CC3}$		0.2	0.6	2.0	mA
Additional Supply Currents (A)	$I_{CC2A}$	Note 3	-2	-	$I_{OHP1X}$	mA
	$I_{CC3A}$	Note 3	0.2	-	2.0	mA
Total Power Dissipation	$P_{TOT}$		-	380	-	mW
Operating Ambient Temperature	$T_A$		-20	-	+70	°C
<b>I<sup>2</sup>C Bus Inuts</b> SDA Input (Pin2); SCL Input (Pin3)						
Input Voltage, HIGH	$V_{IH}$	Note 4	3	-	$V_{CC-1}$	V
Input Voltage, LOW	$V_{IL}$		-0.3	-	1.5	V
Input Current, HIGH	$I_{IH}$	Note 4	-	-	10	μA
Input Current, LOW	$I_{IL}$		-	-	10	μA
<b>I<sup>2</sup>C Bus Outputs</b> SDA Output (Pin2, Open Collector)						
Output Voltage, LOW	$V_{OL}$	$I_{OL} = 3\text{mA}$	-	-	0.4	V
Maximum Output Sink Current	$I_{OL}$		-	5	-	mA
<b>Open-Collector I/O Ports</b> P20, P21, P22, P23 (Pin4 to Pin7, Open Collector)						
Input Voltage, HIGH	$V_{IH}$		2	-	16	V
Input Voltage, LOW	$V_{IL}$		-0.3	-	0.8	V
Input Current, HIGH	$I_{IH}$		-	-	25	μA
Input Current, LOW	$I_{IL}$		-	-	25	μA
Output Voltage, LOW	$V_{OL}$	$I_{OL} = 2\text{mA}$	-	-	0.4	V
Maximum Output Sink Current	$I_{OL}$		-	4	-	mA

Note 3. For each band-select output which is programmed at logic 1, sourcing a current  $I_{OOP1X}$ , the additional supply currents (A) shown must be added to  $I_{CC2}$  and  $I_{CC3}$ , respectively.

Note 4. If  $V_{CC1} < 1\text{V}$ , the input current is limited to 10μA at input voltages up to 16V.

**DC and AC Electrical Characteristics (Cont'd):** ( $T_A = +25^\circ\text{C}$ ,  $V_{CC1}$ ,  $V_{CC2}$ ,  $V_{CC3}$  at typical voltages unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>AFC Amplifier</b> Inputs AFC+, AFC– (Pin8, Pin9)						
Transconductance for Input Voltages up to 1V Differential	g00	AFCS1: 0, AFCS2: 0	100	250	800	nA/V
	g01	AFCS1: 0, AFCS2: 1	15	25	35	$\mu\text{A/V}$
	g10	AFCS1: 1, AFCS2: 0	30	50	70	$\mu\text{A/V}$
	g11	AFCS1: 1, AFCS2: 1	60	100	140	$\mu\text{A/V}$
Tolerance of Transconductance Multiplying Factor (2, 4, or 8) when Correction-in-Band is Used	$\Delta M_g$		-20	-	+20	%
Input Offset Voltage	$V_{IOFF}$		-75	-	+75	mV
Common-Mode Input Voltage	$V_{COM}$		3	-	$V_{CC1}-2.5$	V
Common-Mode Rejection Ratio	CMRR		-	50	-	dB
Power Supply ( $V_{CC1}$ ) Rejection Ratio	PSRR		-	50	-	dB
Input Current	$I_I$		-	-	500	nA
<b>Tuning Voltage Amplifier</b> Input TI, Output TUN (Pin10, Pin12)						
Maximum Output Voltage	$V_{TUN}$	$I_{LOAD} = \pm 2.5\text{mA}$	$V_{CC3}-1.6$	-	$V_{CC3}-0.4$	V
Maximum Output Voltage	$V_{TM00}$	$I_{LOAD} = \pm 2.5\text{mA}$ , $V_{TMI1}: 0$ , $V_{TMI0}: 0$	300	-	500	mV
	$V_{TM10}$	$I_{LOAD} = \pm 2.5\text{mA}$ , $V_{TMI1}: 1$ , $V_{TMI0}: 0$	450	-	650	mV
	$V_{TM11}$	$I_{LOAD} = \pm 2.5\text{mA}$ , $V_{TMI1}: 1$ , $V_{TMI0}: 1$	650	-	900	mV
Maximum Output Source Current	$-I_{TUNH}$		2.5	-	8.0	mA
Maximum Output Sink Current	$I_{TUNL}$		-	40	-	mA
Input Bias Current	$I_{TI}$		-5	-	+5	nA
Power Supply ( $V_{CC3}$ ) Rejection Ratio	PSRR		-	60	-	dB
Minimum Charge IT to Tuning Voltage Amplifier	$CH_{00}$	TUHN1: 0, TUHN0: 0	0.4	1.0	1.7	$\mu\text{A/V}$
	$CH_{01}$	TUHN1: 0, TUHN0: 1	4	8	14	$\mu\text{A/V}$
	$CH_{10}$	TUHN1: 1, TUHN0: 0	15	30	48	$\mu\text{A/V}$
	$CH_{11}$	TUHN1: 1, TUHN0: 1	130	250	370	$\mu\text{A/V}$
Tolerance of Charge (or $\Delta V_{TUN}$ ) Multiplying Factor when COIB and/or TUS are Used	$\Delta CH$		-20	-	+20	%
Maximum Current I into Tuning Amplifier	$I_{T00}$	TUHN1: 0, TUHN0: 0	1.7	3.5	5.1	$\mu\text{A}$
	$I_{T01}$	TUHN1: 0, TUHN0: 1	15	29	41	$\mu\text{A}$
	$I_{T10}$	TUHN1: 1, TUHN0: 0	65	110	160	$\mu\text{A}$
	$I_{T11}$	TUHN1: 1, TUHN0: 1	530	875	1220	$\mu\text{A}$
<b>Correction-in-Band</b>						
Tolerance of Correction-in-Band Levels 12V, 18V, and 24V	$\Delta V_{CIB}$		-15	-	+15	%
<b>Band-Select Output Ports</b> P10, P11, P12, P13 (Pin15 to Pin18)						
Output Voltage, HIGH	$V_{OH}$	$-I_{OH} = 50\text{mA}$ , Note 5	$V_{CC2}-0.6$	-	-	V
Output Voltage, LOW	$V_{OL}$	$I_{OL} = 2\text{mA}$	-	-	0.4	V

Note 5. At continuous operation the output current should not exceed 50mA. When the output is short-circuited to GND for several seconds the device may be damaged.

**DC and AC Electrical Characteristics (Cont'd):** ( $T_A = +25^\circ\text{C}$ ,  $V_{CC1}$ ,  $V_{CC2}$ ,  $V_{CC3}$  at typical voltages unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>Band-Select Output Ports (Cont'd)</b> P10, P11, P12, P13 (Pin15 to Pin18)						
Maximum Output Source Current	$-I_{OH}$	Note 5	–	130	200	mA
Maximum Output Sink Current	$I_{OL}$		–	5	–	mA
<b>FDIV Input (Pin20)</b>						
Input Voltage (Peak-to-Peak Value)	$V_{FDIV}^{P-P}$	$t_{RISE}$ and $t_{FALL} \leq 40\text{ns}$	0.1	–	2.0	V
Duty Cycle			40	–	60	%
Maximum Input Frequency	$f_{MAX}$		14.5	–	–	MHz
Input Impedance	$Z_i$		–	8	–	$k\Omega$
Input Capacitance	$C_i$		–	5	–	pF
<b>OSC Input (Pin21)</b>						
Crystal Resistance at Resonance (4MHz)	$R_X$		–	–	150	$\Omega$
<b>DAC Outputs (Pin1, Pin22 to Pin24)</b>						
Maximum Output Voltage (No Load)	$V_{DH}$	$V_{CC1} = 12\text{V}$ , Note 6	10.0	–	11.5	V
Minimum Output Voltage (No Load)	$V_{DL}$	$V_{CC1} = 12\text{V}$ , Note 6	0.1	–	1.0	V
Positive Value of Smallest Step	$\Delta V_D$	1 Least Significant Bit	0	–	350	mV
Deviation from Linearity			–	–	0.5	V
Output Impedance	$Z_D$	$I_{LOAD} = \pm 2\text{mA}$	–	–	70	$\Omega$
Maximum Output Source Current	$-I_{DH}$		–	–	6	mA
Maximum Output Sink Current	$I_{DL}$		–	8	–	mA
<b>Power-Down Reset</b>						
Maximum Supply Voltage ( $V_{CC1}$ ) at which Power-Down Reset is Active	$V_{PD}$		7.5	–	9.5	V
$V_{CC1}$ Rise Time During Power-Up (Up to $V_{PD}$ )	$t_R$		5	–	–	$\mu\text{s}$
<b>Voltage Level for Valid Module Address</b>						
Voltage Level at P20 (Pin4) for Valid Module Address as a Function of MA1, MA0	$V_{VA00}$	MA1: 0, MA0: 0	–0.3	–	16	V
	$V_{VA01}$	MA1: 0, MA0: 1	–0.3	–	0.8	V
	$V_{VA10}$	MA1: 1, MA0: 0	2.5	–	$V_{CC1}-2$	V
	$V_{VA11}$	MA1: 1, MA0: 1	$V_{CC1}-0.3$	–	$V_{CC1}$	V

Note 5. At continuous operation the output current should not exceed 50mA. When the output is short-circuited to GND for several seconds the device may be damaged.

Note 6. Values are proportional to  $V_{CC1}$ .

### Pin Connection Diagram

