

# LVDT signal conditioner

# NE/SA/SE5521

## DESCRIPTION

The NE/SA/SE5521 is a signal conditioning circuit for use with Linear Variable Differential Transformers (LVDTs) and Rotary Variable Differential Transformers (RVDTs). The chip includes a low distortion, amplitude-stable sine wave oscillator with programmable frequency to drive the primary of the LVDT/RVDT, a synchronous demodulator to convert the LVDT/RVDT output amplitude and phase to position information, and an output amplifier to provide amplification and filtering of the demodulated signal.

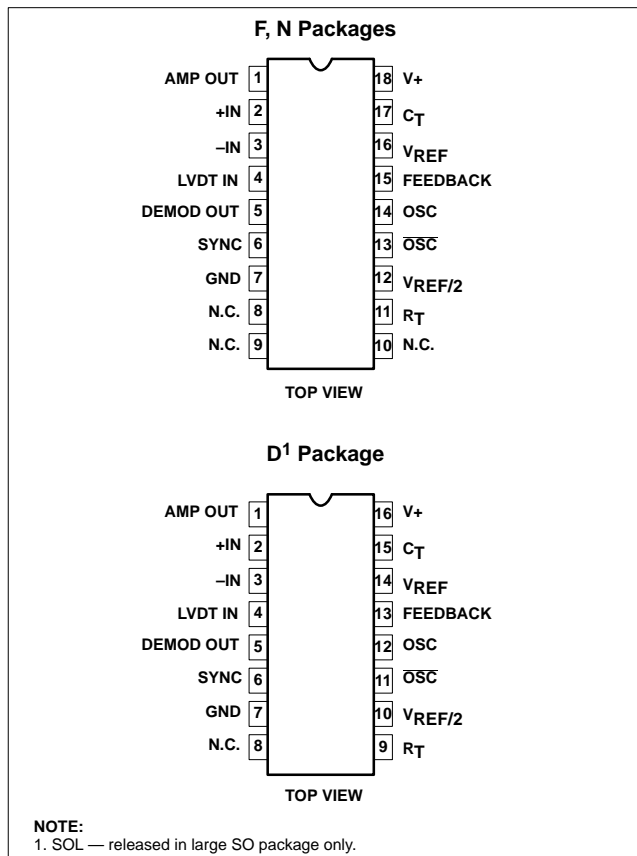
## FEATURES

- Low distortion
- Single supply 5V to 20V, or dual supply  $\pm 2.5V$  to  $\pm 10V$
- Oscillator frequency 1kHz to 20kHz
- Capable of ratiometric operation
- Low power consumption (182mV typ)

## APPLICATIONS

- LVDT signal conditioning
- RVDT signal conditioning
- LPDT signal conditioning
- Bridge circuits

## PIN CONFIGURATIONS



## ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
18-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	NE5521N	0407A
16-Pin Small Outline Large (SOL) Package	0 to +70°C	NE5521D	0171B
18-Pin Plastic Dual In-Line Package (DIP)	-40 to +85°C	SA5521N	0407A
18-Pin Ceramic Dual In-Line Package (CERDIP)	-55 to +125°C	SE5521F	0583A
16-Pin Ceramic Dual In-Line Package (CERDIP)	-40 to +85°C	SA5521D	0582B

## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V <sub>CC</sub>	Supply voltage	+20	V
	Split supply voltage	$\pm 10$	V
T <sub>A</sub>	Operating temperature range		
	NE5521	0 to 70	°C
	SA5521	-40 to +85	°C
	SE5521	-55 to +125	°C
T <sub>STG</sub>	Storage temperature range	-65 to +125	°C
P <sub>D</sub>	Power dissipation <sup>1</sup>	910	mW

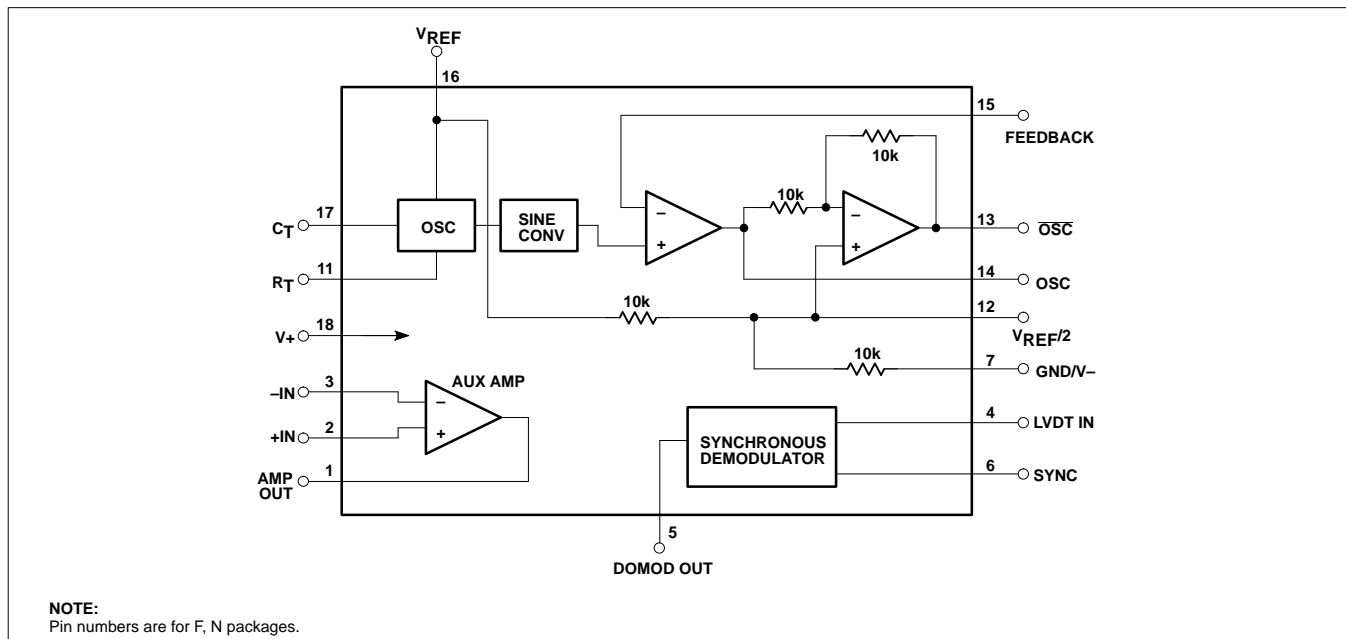
### NOTES:

1. For derating, see typical power dissipation versus load curves (Figure 1).

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## BLOCK DIAGRAM



## PIN DEFINITIONS FOR D, F AND N PACKAGES

PIN NO.		SYMBOL	DEFINITION
D	F, N		
1	1	Amp Out	Auxiliary Amplifier Out.
2	2	+IN	Auxiliary Amplifier non-inverting input.
3	3	-IN	Auxiliary Amplifier inverting input.
4	4	LVDT IN	Input to Synchronous Demodulator from the LVDT/RVDT secondary.
5	5	DEMOD OUT	Pulsating DC output from the Synchronous Demodulator output. This voltage should be filtered before use.
6	6	SYNC	Synchronizing input for the Synchronizing Demodulator. This input should be connected to the OSC or OSC output. Sync is referenced to V <sub>REF</sub> /2.
7	7	GND	Device return. Should be connected to system ground or to the negative supply.
8	8	NC	No internal connection.
--	9	NC	No internal connection.
--	10	NC	No internal connection.
9	11	R <sub>T</sub>	A temperature stable 18kΩ resistor should be connected between this pin and Pin 7.
10	12	V <sub>REF</sub> /2	A high impedance source of one half the potential applied to V <sub>REF</sub> . The LVDT/RVDT secondary return should be to this point. A bypass capacitor with low impedance at the oscillator frequency should also be connected between this pin and ground.
11	13	OSC	Oscillator sine wave output that is 180° out of phase with the OSC signal. The LVDT/RVDT primary is usually connected between OSC and OSC pins.
12	14	OSC	Oscillator sine wave output. The LVDT/RVDT primaries are usually connected between OSC and OSC pins.
13	15	FEEDBACK	Usually connected to the OSC output for unity gain, a resistor between this pin and OSC, and one between this pin and ground can provide for a change in the oscillator output pin amplitudes.
14	16	V <sub>REF</sub>	Reference voltage input for the oscillator and sine converter. This voltage MUST be stable and must not exceed +V supply voltage.
15	17	C <sub>T</sub>	Oscillator frequency-determining capacitor. The capacitor connected between this pin and ground should be a temperature-stable type.
16	18	+V	Positive supply connection.

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**DC ELECTRICAL CHARACTERISTICS**

$V_+ = V_{REF} = 10V$ ,  $T_A = 0$  to  $70^\circ\text{C}$  for NE5521,  $T_A = -55$  to  $+125^\circ\text{C}$  for SE5521,  $T_A = -40$  to  $85^\circ\text{C}$  for SA5521, Frequency = 1kHz, unless otherwise noted.

SYMBOL	PARAMETER	TEST CONDITIONS	NE5521			SA/SE5521			UNIT
			Min	Typ	Max	Min	Typ	Max	
$V_{CC}$	Supply current			12.9	20		12.9	18	mA
$I_{REF}$	Reference current			5.3	8		5.3	8	mA
$V_{REF}$	Reference voltage range		5		$V_+$	5		$V_+$	V
$P_D$	Power dissipation			182	280		182	260	mW
<b>Oscillator Section</b>									
	Oscillator output	$R_L = 10k\Omega$	$\frac{V_{REF}}{8.8}$				$\frac{V_{REF}}{8.8}$		$V_{RMS}$
THD	Sine wave distortion	No load		1.5			1.5		%
	Initial amplitude error	$T_A = 25^\circ\text{C}$		0.4	$\pm 3$		0.4	$\pm 3$	%
	Tempco of amplitude			0.005	0.01		0.005	0.01	$\%/^\circ\text{C}$
	Init. accuracy of oscillator freq.	$T_A = 25^\circ\text{C}$		$\pm 0.9$	$\pm 5$		$\pm 0.9$	$\pm 5$	%
	Temperature coeff. of frequency <sup>1</sup>			0.05			0.05		$\%/^\circ\text{C}$
	Voltage coeff. of frequency			2.5			3.3		$\%/V(V_{REF})$
	Min OSC (OSC) Load <sup>2</sup>		300	170		300	170		$\Omega$
<b>Demodulator Section</b>									
$\epsilon_r$	Linearity error	$5V_{P-P}$ input		$\pm 0.05$	$\pm 0.1$		$\pm 0.05$	$\pm 0.1$	%FS
	Maximum demodulator input			$\frac{V_{REF}}{2}$			$\frac{V_{REF}}{2}$		$V_{P-P}$
$V_{OS}$	Demodulator offset voltage			$\pm 1.4$	$\pm 5$		$\pm 1.4$	$\pm 5$	mV
$TCV_{OS}$	Demodulator offset voltage drift			5	25		5	25	$\mu V/^\circ\text{C}$
$I_{BIAS}$	Demodulator input current		-600	-234		-500	-234		nA
	$V_{R/2}$ accuracy			$\pm 0.1$	$\pm 1$		$\pm 0.1$	$\pm 1$	%
<b>Auxiliary Output Amplifier</b>									
$V_{OS}$	Input offset voltage			$\pm 0.5$	$\pm 5$		$\pm 0.5$	$\pm 5$	mV
$I_{BIAS}$	Input bias current		-600	-210		-500	-210		nA
$I_{OS}$	Input offset current			10	50		10	50	nA
$A_V$	Gain		100	385		100	385		V/mV
SR	Slew rate			1.3			1.3		V/ $\mu\text{s}$
GBW	Unity gain bandwidth product	$A_V = 1$		1.6			1.6		MHz
	Output voltage swing	$R_L = 10k\Omega$	7	8.2		7	8.2		V
	Output short circuit current to ground or to $V_{CC}$	$T_A = 25^\circ\text{C}$		42	100		42	100	mA

**NOTES:**

1. This is temperature coefficient of frequency for the device only. It is assumed that  $C_T$  and  $R_T$  are fixed in value and  $C_T$  leakage is fixed over the operating temperature range.
2. Minimum load impedance for which distortion is guaranteed to be less than 5%.

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## DEFINITION OF TERMS

<b>Oscillator Output</b>	RMS value of the AC voltage at the oscillator output pin. This output is referenced to $V_{REF}/2$ and is a function of $V_{REF}$ .
<b>Sine Wave Distortion</b>	The Total Harmonic Distortion (THD) of the oscillator output with no load. This is not a critical specification in LVDT/RVDT systems. This figure could be 15% or more without affecting system performance.
<b>Initial Amplitude Error</b>	A measure of the interchangeability of NE/SA/SE5521 parts, not a characteristic of any one part. It is the degree to which the oscillator output of a number of NE/SA/SE5521 samples will vary from the median of that sample.
<b>Initial Accuracy of Oscillator Frequency</b>	Another measure of the interchangeability of individual NE/SA/SE5521 parts. This is the degree to which the oscillator frequency of a number of NE/SA/SE5521 samples will vary from the median of that sample with a given timing capacitor.
<b>Tempco of Oscillator Amplitude</b>	A measure of how the oscillator amplitude varies with ambient temperature as that temperature deviates from a 25°C ambient.
<b>Tempco of Oscillator Frequency</b>	A measure of how the oscillator frequency varies with ambient temperature as that temperature deviates from a 25°C ambient.
<b>Voltage Coefficient of Oscillator Frequency</b>	The degree to which the oscillator frequency will vary as the reference voltage ( $V_{REF}$ ) deviates from +10V.
<b>Min OSC (OSC) Load</b>	Minimum load impedance for which distortion is guaranteed to be less than 5%.
<b>Linearity Error</b>	The degree to which the DC output of the demodulator/amplifier combination matches a change in the AC signal at the demodulator input. It is measured as the worst case nonlinearity from a straight line drawn between positive and negative fullscale end points.
<b>Maximum Demodulator Input</b>	The maximum signal that can be applied to the demodulator input without exceeding the specified linearity error.

## APPLICATION INFORMATION

$$\text{OSC frequency} = \frac{V_{REF} - 1.3V}{V_{REF} (R_T + 1.5k) C_T}$$

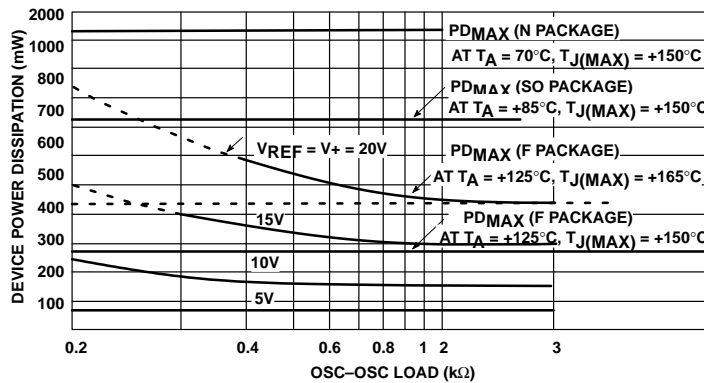
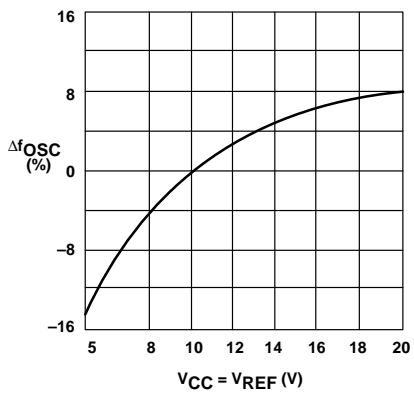


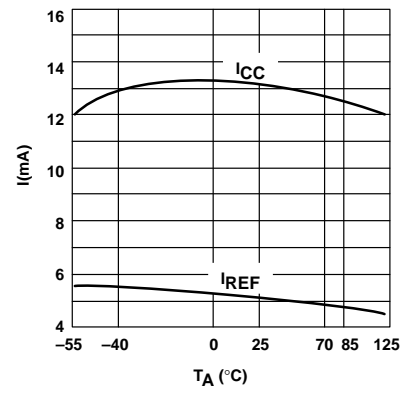
Figure 1. Device Power Dissipation vs OSC – OSC Load at +25°C

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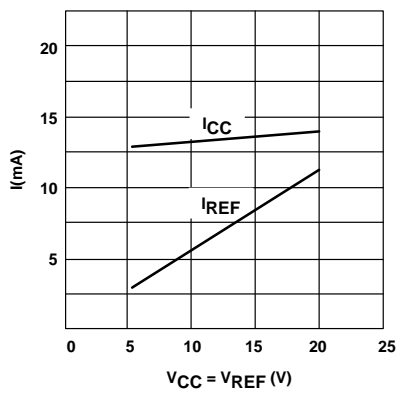
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**Figure 2. Oscillator Frequency Variation With Voltage (Normalized to V<sub>REF</sub> = V<sub>CC</sub> = 10V) T<sub>A</sub> = +25°C**



**Figure 4. I<sub>REF</sub> and I<sub>CC</sub> vs Temperature (V<sub>REF</sub> = V<sub>CC</sub> = 10V)**



**Figure 3. I<sub>REF</sub> and I<sub>CC</sub> vs Voltage (T<sub>A</sub> = +25°C)**

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