RADIAL ERROR SIGNAL PROCESSOR
FOR COMPACT DISC PLAYERS

GENERAL DESCRIPTION

The TDA5709 is a bipolar integrated circuit which provides control signals for the radial motor.
These control signals are generated from radial error signals received from a photo-diode signal
processor (TDA5708), and velocity control signals from the control processor.

Features

- Tracking error processor with automatic asymmetry control
- A.G.C. circuitry with automatic start-up and wobble generator
- Tracking control for fast forward/reverse scan, search, repeat and pause functions
- TTL compatible digital input/output
- Digitalized tracking error signal
- Possibility for car application

QUICK REFERENCE DATA

Supply voltage range	$V_{DD}-V_{BB}$		8 to 13 V
Quiescent supply current	I_Q	typ.	6 mA
Operating ambient temperature range	T_{amb}		-30 to $+85$ °C

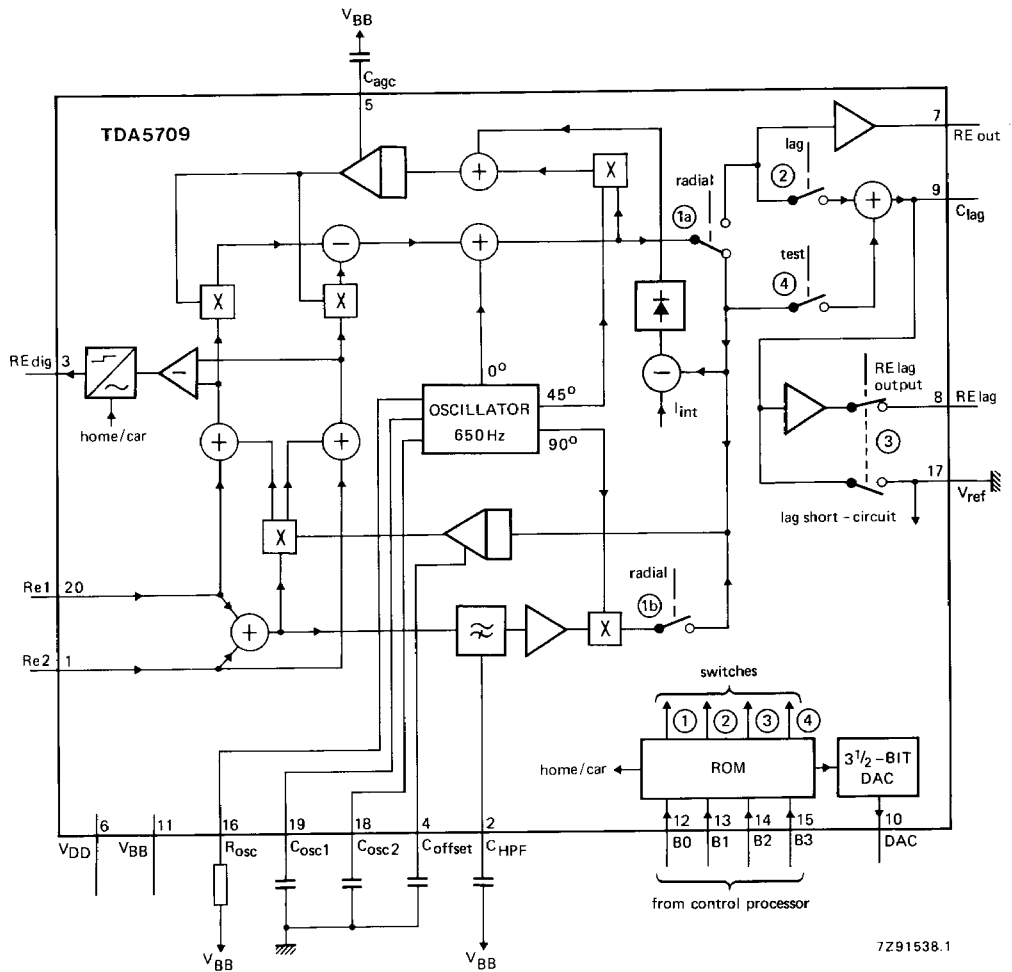## PACKAGE OUTLINE

20-lead DIL; plastic (SOT146).

Fig. 1 Block diagram.

PIN DESCRIPTION

Pin No.	Symbol	Description
1	Re2	Input for amplified currents from photo diodes D1 and D2
2	C_{HPF}	High-pass filter for Re1 and Re2, used for radial offset control
3	REdig	Digital output of sign (Re2 − Re1)
4	C_{offset}	Offset control input for radial offset
5	C_{agc}	Gain control input for radial error signal
6	V_{DD}	Positive supply voltage
7	REout	Current output of amplified (Re2 − Re1) input currents
8	RElag	Voltage output of integrated (Re2 − Re1) input currents
9	C_{lag}	Integrator capacitor for (Re1 − Re2) input currents
10	DAC	Current output for track jumping (3½ bits)
11	V_{BB}	Negative supply connection (also substrate connection)
12	B0	Input control bits for off-, catch-, play-status and DAC output current
13	B1	
14	B2	
15	B3	
16	R_{osc}	Biassing resistor for oscillator frequency and internal amplitude
17	V_{ref}	Intermediate supply voltage
18	C_{osc2}	Frequency setting capacitors for oscillator
19	C_{osc1}	
20	Re1	Input for amplified currents from photo-diodes D3 and D4

DEVELOPMENT DATA
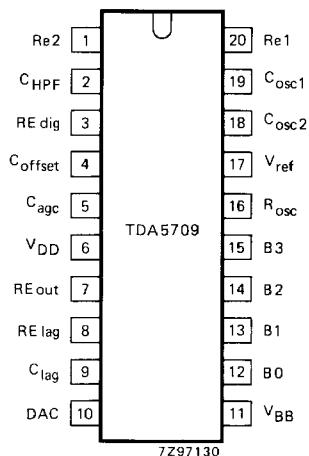
Fig. 2 Pinning diagram.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage range ($V_{DD} - V_{BB}$)			
pin 6 — pin 11	$V_{DD} - V_{BB}$	−0,3 to + 13	V
Total power dissipation	P_{tot}	see Fig. 3	
Storage temperature range	T_{stg}	−55 to + 150	^oC
Operating ambient temperature range	T_{amb}	−30 to + 85	^oC
Operating junction temperature	T_j	max. 150	^oC

THERMAL RESISTANCE

From junction to ambient	$R_{th\ j\text{-}a}$	=	72 K/W
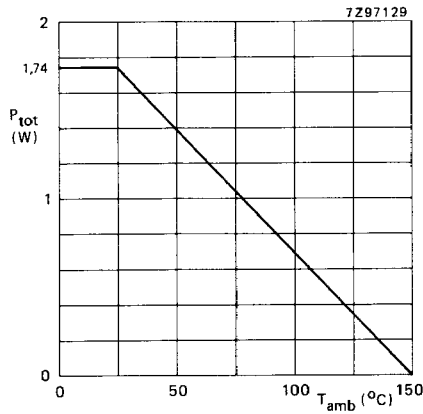
Fig. 3 Power derating curve.

CHARACTERISTICS

V_{DD} = + 5 V; V_{BB} = −5 V; T_{amb} = 25 °C; V_{ref} = 0 V; R_{osc} = 24 kΩ; all voltages with respect to V_{ref}; unless otherwise specified.

parameter	symbol	min.	typ.	max.	unit
Supplies					
Supply voltage					
pin 6 − pin 11 (V_{DD} − V_{BB})		8	−	13	V
pin 17 − pin 11 (V_{ref} − V_{BB})		4,5	5,0	5,5	V
Quiescent supply current	I_Q	−	6	−	mA
REdig output (pin 3)					
Output voltage level					
HIGH (note 1; C)	V_{REdig}	V_{ref} + 2,4	−	−	V
LOW (note 1; A)	V_{REdig}	V_{ref} −0,3	−	V_{ref} + 0,4	V
LOW (note 1; B)	V_{REdig}	V_{BB}	−	V_{BB} + 0,4	V
Output current					
sink current (note 1; A or B)	I_{REdig}	400	−	−	μA
source current (note 1; C)	I_{REdig}	−	−150	−50	μA
Digital inputs (pins 12 to 15)					
B0, B1, B2 and B3					
Input voltage HIGH (note 2)	V_B	V_{ref} + 2	−	V_{DD}	V
Input voltage LOW (note 2)	V_B	V_{BB} + 2	−	V_{ref} + 0,8	V
Input voltage HIGH (note 3)	V_B	V_{BB} + 2	−	V_{DD}	V
Input voltage LOW (note 3)	V_B	V_{BB} −0,3	−	V_{BB} + 0,8	V
Input current					
at V_B = HIGH	I_B	−	0	−	μA
at V_B = LOW	I_B	−	−	−10	μA
DAC output (pin 10)					
Output voltage range					
at I_{DAC} = + 150 μA (sink current)	V_{DAC}	V_{BB} + 1,5	−	V_{DD}	V
at I_{DAC} = − 150 μA (source current)	V_{DAC}	V_{BB}	−	V_{DD} −1	V
Output impedance					
at I_{DAC} = 200 μA	$|Z_{DAC}|$	−	50	−	MΩ

CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
DAC output (continued)					
Ratio of output current pin 10 to pin 16 (see Table 1)	I_{10}/I_{16}	3,6	4	4,4	
		−4,6	−4	−3,4	
		0,9	1	1,1	
		−1,2	−1	−0,8	
		0,68	0,75	0,82	
		−0,86	−0,75	−0,64	
		0,45	0,5	0,55	
		−0,58	−0,5	−0,42	
		0,23	0,25	0,27	
		−0,29	−0,25	−0,2	
Analogue input (pin 16)					
Input voltage level	V_{Rosc}	−	$V_{BB}+1,2$	−	V
Input current level	I_{Rosc}	−	−50	−	μA
Radial error inputs (Re1 pin 20, Re2 pin 1)					
Input voltage level at I_{Re1}, $I_{Re2} = -105\ \mu$A	V_{Re1}, V_{Re2}	−	$V_{BB}+1,4$	−	V
Input current	I_{Re1}, I_{Re2}	−	105	−	μA
Input impedance	$|Z_{Re1}|$, $|Z_{Re2}|$	−	1	−	kΩ
Gain control input (pin 5)					
Input voltage for minimum radial gain	V_{Cagc}	−	$V_{BB}+3,5$	−	V
maximum radial gain	V_{Cagc}	−	$V_{BB}+5,5$	−	V
Input impedance	$|Z_{Cagc}|$	−	20	−	MΩ
Offset control (pin 4)					
Output current at $I_{Re1} = I_{Re2} = -105\ \mu$A; $V_{Cosc1} = V_{Cosc2} = V_{ref}$	$-I_{Coffset}$	−	0,25	−	μA
Input voltage for maximum amplification Re1	$V_{Coffset}$	−	$V_{ref}-1$	−	V
minimum amplification Re2	$V_{Coffset}$	−	$V_{ref}-1$	−	V
minimum amplification Re1	$V_{Coffset}$	−	$V_{ref}+1$	−	V
maximum amplification Re2	$V_{Coffset}$	−	$V_{ref}+1$	−	V
Input impedance	$|Z_{Coffset}|$	−	30	−	MΩ

DEVELOPMENT DATA

parameter	symbol	min.	typ.	max.	unit
High-pass filter (pin 2)					
Voltage level					
at $I_{Re1} = I_{Re2} = 0$	V_{HPF}	–	$V_{BB} + 2,8$	–	V
Impedance	$|Z_{HPF}|$	–	5	–	kΩ
Oscillator					
(C_{oscl} pin 19, C_{osc2} pin 18)					
Linear input voltage range					
V_{Coscl}, V_{Cosc2}	V_{Cosc}	$V_{ref} - 2$	–	$V_{ref} + 2$	V
RElag voltage output (pin 8)					
Output voltage range					
at $I_{RElag} = + 200 \mu A$ (sink current)	V_{RElag}	$V_{BB} + 1,5$	–	V_{DD}	V
at $I_{RElag} = - 200 \mu A$ (source current)	V_{RElag}	V_{BB}	–	$V_{DD} - 1$	V
Maximum source current output	I_{RElag}	–	$-2,5$	–	mA
Maximum sink current output	I_{RElag}	–	4	–	mA
Output impedance (f < 10 kHz)					
with RElag switched on	$|Z_{RElag}|$	–	–	50	Ω
with RElag switched off	$|Z_{RElag}|$	1	–	–	MΩ
REout push-pull current output (pin 7)					
Output voltage range					
at $I_{REout} = + 40 \mu A$ (sink current)	V_{REout}	$V_{BB} + 1,5$	–	V_{DD}	V
at $I_{REout} = - 40 \mu A$ (source current)	V_{REout}	V_{BB}	–	$V_{DD} - 1$	V
Output impedance	$|Z_{REout}|$	–	2	–	MΩ
C_{lag} push-pull current output/voltage input (pin 9)					
Output voltage range					
at $I_{Clag} = + 4 \mu A$ (sink current)	V_{Clag}	$V_{BB} + 1,5$	–	V_{DD}	V
at $I_{Clag} = - 4 \mu A$ (source current)	V_{Clag}	V_{BB}	–	$V_{DD} - 1,5$	V
Output impedance	$|Z_{Clag}|$	–	15	–	MΩ

CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
TRANSFER SPECIFICATIONS					
Oscillator (pins 19, 18)					
(V_{osc1}, V_{osc2}: -2 V to $+2$ V)					
Transconductance factor					
$\dfrac{I_{Cosc2}}{V_{Cosc1}} \cdot R_{osc}$		$-$	0,48	$-$	
$\dfrac{I_{Cosc1}}{V_{Cosc2}} \cdot R_{osc}$		$-$	$-0,48$	$-$	
Amplitude stabilization					
$I_{osc1} = f(V_{osc1})$ at $V_{Cosc2} = 0$					
$\quad V_{osc1} = 0$ V	I_{osc1}	$-$	0,1	$-$	μA
$\quad V_{osc1} = +0,87$ V	I_{osc1}	$-$	$M_2 + 1,4$	$-$	μA
$\quad V_{osc1} = -0,87$ V	I_{osc1}	$-$	$M_2 - 1,4$	$-$	μA
$\quad V_{osc1} = +1,2$ V (note 4)	I_{osc1}	$-$	M_2	$-$	μA
$\quad V_{osc1} = -1,2$ V	I_{osc1}	$-$	M_2	$-$	μA
$\quad V_{osc1} = +1,8$ V	I_{osc1}	$-$	$M_2 - 3,5$	$-$	μA
$\quad V_{osc1} = -1,8$ V	I_{osc1}	$-$	$M_2 + 3,5$	$-$	μA
Amplitude stabilization					
$I_{osc2} = f(V_{osc2})$ at $V_{Cosc1} = 0$					
$\quad V_{osc2} = 0$ V	I_{osc2}	$-$	0,1	$-$	μA
$\quad V_{osc2} = +0,87$ V	I_{osc2}	$-$	$M_3 + 1,4$	$-$	μA
$\quad V_{osc2} = -0,87$ V	I_{osc2}	$-$	$M_3 - 1,4$	$-$	μA
$\quad V_{osc2} = +1,2$ V (note 5)	I_{osc2}	$-$	M_3	$-$	μA
$\quad V_{osc2} = -1,2$ V	I_{osc2}	$-$	M_3	$-$	μA
$\quad V_{osc2} = +1,8$ V	I_{osc2}	$-$	$M_3 - 3,5$	$-$	μA
$\quad V_{osc2} = -1,8$ V	I_{osc2}	$-$	$M_3 + 3,5$	$-$	μA
Transconductance factor					
$\dfrac{I_{Clag}}{V_{osc1}} \cdot R_{osc}$					
$\quad$ with test on; radial off; $I_{Re1} = I_{Re2} = 0$		$-$	$-0,08$	$-$	

DEVELOPMENT DATA

parameter	symbol	min.	typ.	max.	unit
Transconductance factor $$\frac{I_{Clag}}{V_{osc1}} \cdot R_{osc}$$ with lag on; radial on; $I_{Re1} = I_{Re2} = 0$		—	−0,08	—	
Transconductance factor $$\frac{I_{REout}}{V_{osc2}} \cdot R_{osc}$$ with radial on; $I_{Re1} = I_{Re2} = 0$		—	0	—	
$$\frac{I_{REout}}{V_{osc1}} \cdot R_{osc}$$ with radial on; $I_{Re1} = I_{Re2} = 0$		—	0,8	—	
Transconductance factor $$\frac{I_{Coffset}}{V_{Cosc2}} \cdot R_{osc}$$ with radial on; $I_{Re1} = I_{Re2} = 0$ at $I_{HPF} = 30\ \mu A$		—	0,48	—	
at $I_{HPF} = 0\ \mu A$		—	0	—	
at $I_{HPF} = -30\ \mu A$		—	−0,48	—	
with radial off; $I_{Re1} = I_{Re2} = 0$ at $I_{HPF} = 30\ \mu A$		—	0	—	
Transconductance factor $$\frac{I_{Coffset}}{V_{Cosc1}} \cdot R_{osc}$$ with radial on; $I_{Re1} = I_{Re2} = 0$ at $I_{HPF} = 30\ \mu A$		—	0	—	
with radial off; $I_{Re1} = I_{Re2} = 0$ at $I_{HPF} = 30\ \mu A$		—	0,08	—	
Transconductance factor $$\frac{I_{agc}}{V_{Cosc1}} \cdot R_{osc}$$ with radial on; $V_{agc} = 0,5\ V$; $V_{Coffset} = V_{Cosc2} = 0\ V$ at $I_{Re1} = -150\ \mu A$; $I_{Re2} = 0$		—	−0,48	—	
at $I_{Re1} = I_{Re2} = -100\ \mu A$		—	note 6	—	
at $I_{Re1} = 0$; $I_{Re2} = -150\ \mu A$		—	+ 0,48	—	

CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit

Transconductance factor
 	
 $\dfrac{I_{agc}}{V_{Cosc2}} \cdot R_{osc}$
 	
 with radial on; $V_{agc} = 0,5$ V;
 $V_{offset} = V_{Cosc1} = 0$ V
      at $I_{Re1} = -150\ \mu A$; $I_{Re2} = 0$
      at $I_{Re1} = I_{Re2} = -100\ \mu A$
      at $I_{Re1} = 0$; $I_{Re2} = -150\ \mu A$
		
		–
		–
		–
			
			–0,48
			0
			+0,48
				
				–
				–
				–	

Transfer $C_{lag} \to RElag$ $\dfrac{V_{RElag}}{V_{Clag}}$; at frequencies < 10 kHz with lag short-circuit off; RElag output on		 –	 1	 –	

Slew rate
 RElag amplifier
    with lag short-circuit off;
    RElag output on
	SR	–	0,4	–	V/μs

Switch lag short-circuit
 	
 Impedance $\dfrac{\Delta V_{Clag}}{\Delta I_{Clag}}$
    with lag short-circuit on;
    $|I_{Clag}| < 10\ \mu A$
	$|Z_{lag\ sc}|$	–	–	1	kΩ

Offset $|V_{Clag} - V_{ref}|$
    with lag short-circuit on;
    $I_{Clag} = 0\ \mu A$
	$|V_{RElag}|$	–	–	10	mV

Transfer resistance (Re1, Re2 to C_{HPF}) $\dfrac{\Delta V_{CHPF}}{\Delta (I_{Re1} + I_{Re2})}$		–	2,5	–	kΩ

Gain (Re1, Re2 to REout)
 	
 $\dfrac{\Delta I_{REout}}{\Delta (I_{Re1} - I_{Re2})}$
    with lag short-circuit on; radial on;
    $V_{Coffset} = V_{osc1} = V_{osc2} = 0$ V
    $V_{agc} = 0,5$ V
		–	5	–	times

DEVELOPMENT DATA

parameter	symbol	min.	typ.	max.	unit
Offset current RE					
Offset current					
with lag short-circuit on; radial on;					
$V_{Coffset} = V_{osc1} = V_{osc2} = 0$ V					
$V_{agc} = 0,5$ V					
at $I_{Re1} = I_{Re2} = 100$ μA	I_{RE}	–	0	–	μA
Gain (Re1, Re2 to C_{agc})					
$\dfrac{\Delta I_{Cagc}}{\Delta (I_{Re1} - I_{Re2})}$ at $I_{Re1} = -104$ μA					
with lag short-circuit on; radial on;					
$V_{Coffset} = $ (see note 7);					
$V_{agc} = 0,5$ V; $V_{Cosc1} = 0$ V;					
$V_{Cosc2} = 1,2$ V;					
$\Delta(I_{Re1} - I_{Re2}) = 8$ μA		–	0,8	–	times
$\dfrac{\Delta I_{Cagc}}{\Delta (I_{Re1} - I_{Re2})}$ at $I_{Re2} = -104$ μA					
with lag short-circuit on; radial on;					
$V_{Coffset} = $ (note 7);					
$V_{agc} = 0,5$ V; $V_{Cosc1} = 0$ V;					
$V_{Cosc2} = 1,2$ V;					
$\Delta(I_{Re2} - I_{Re1}) = 8$ μA		–	–0,8	–	times
Offset current I_{Cagc}					
Offset current					
with lag short-circuit on; radial on;					
$V_{Cosc1} = 0$ V; $V_{Cosc2} = 0$ V					
$V_{agc} = 0,5$ V					
at $I_{Re1} = I_{Re2} = -100$ μA	I_{Cagc}	–	0	–	μA
Transconductance factor					
$\dfrac{\Delta I_{RE} \cdot V_{RANGE}}{I_{tot} \cdot V_{Coffset}}$					
with $V_{Cosc1} = V_{Cosc2} = 0$ V;					
radial on; $V_{agc} = -3$ V;					
$V_{RANGE} = 1$ V (internal);					
$I_{tot} = I_{Re1} + I_{Re2}$					
at $I_{Re1} = I_{Re2} = -100$ μA		–	2,5	–	
$\dfrac{\Delta I_{RE} \cdot V_{RANGE}}{I_{tot} \cdot V_{Coffset}}$					
with $V_{Cosc1} = V_{Cosc2} = 0$ V;					
radial on; $V_{agc} = V_{BB}$;					
$V_{RANGE} = 1$ V (internal);					
$I_{tot} = I_{Re1} + I_{Re2}$					
at $I_{Re1} = I_{Re2} = -100$ μA		–	0	–	

CHARACTERISTICS (continued)

parameter	symbol	min.	typ.	max.	unit
Gain control current I_{agc}					

I_{agc}
    with $V_{Cosc1} = V_{Cosc2} = 0$ V; $V_{agc} = 0,5$ V;
    radial off; $V_{Coffset} = 0$ V					

at $I_{REtot} = 200$ μA; $I_{Re1} - I_{Re2} = 35$ μA	I_{agc}	–	0	–	μA
at $I_{REtot} = 200$ μA; $I_{Re1} - I_{Re2} = 65$ μA	I_{agc}	–	50	–	μA

Notes to the characteristics

1. REdig output conditions:

    A: $I_{Re1} > I_{Re2} + 5$ μA; $V_{Coffset} = V_{ref}$; B0 and B1 and B2 and B3 $> V_{BB} + 2,0$ V.

    B: $I_{Re1} > I_{Re2} + 5$ μA; $V_{Coffset} = V_{ref}$; B0 or B1 or B2 or B3 $< V_{BB} + 0,8$ V.

    C: $I_{Re2} > I_{Re1} + 5$ μA; $V_{Coffset} = V_{ref}$; don't cares for B0, B1, B2 and B3.

2. In the 'home' application all logical inputs B0, B1, B2 and B3 must be $> V_{BB} + 2$ V.

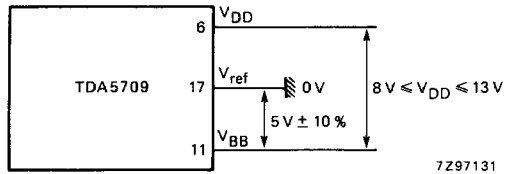Fig. 4 TDA5709 'home' application.

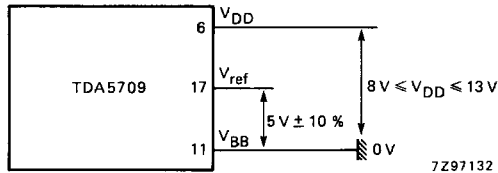3. In the 'car' application one or more of the logical inputs B0, B1, B2, B3 must be $< V_{BB} + 0,8$ V.

Fig. 5 TDA5709 'car' application.

4. M_2 is the measured value of I_{osc1} at $V_{osc1} = 0$ V.

5. M_3 is the measured value of I_{osc2} at $V_{osc2} = 0$ V.

6. Parabolic curve.

7. $V_{Coffset}$ must be adjusted so that $I_{Clag} = 4$ μA.
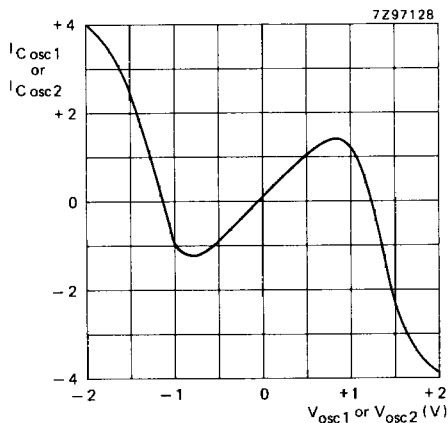
Fig. 6 Amplitude stabilization (typical curve).

Table 1 Truth table for DAC output current

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type names	DAC output (μA)*	logical inputs				internal switches				
		B0	B1	B2	B3	lag	lag s/c	rad	test	output RElag
OFF	0	0	0	0	0	off	on	off	off	off
CATCH	0	0	0	0	1	off	on	on	off	off
PUSH	−200	0	0	1	0	off	on	off	off	off
(kick)	−200	0	0	1	1	off	off	off	off	on
PULL	50	0	1	0	0	off	on	off	off	off
PULL	37,5	0	1	0	1	off	on	off	off	off
PULL	25	0	1	1	0	off	on	off	off	off
PULL	12,5	0	1	1	1	off	on	off	off	off
PUSH	−50	1	0	0	0	off	on	off	off	off
PUSH	−37,5	1	0	0	1	off	on	off	off	off
PUSH	−25	1	0	1	0	off	on	off	off	off
PUSH	−12,5	1	0	1	1	off	on	off	off	off
PULL	200	1	1	0	0	off	on	off	off	off
(kick)	200	1	1	0	1	off	off	off	off	on
play	0	1	1	1	0	on	off	on	off	on
test**	0	1	1	1	1	off	off	off	on	on

Where:

0 = input voltage LOW; 1 = input voltage HIGH.

*   With R_{osc} = 24 kΩ.

** Non-proper operating of output REdig if the logical zero is close to V_{BB}.