HA16817NT/HA16817MP

Preliminary

SLIC IC for PBX Applications

Bipolar linear process monolithic SLIC IC for PBX applications

Features

- Basic Functions: Internal battery feed control (B), loop monitor (S) and 2 W–4 W conversion
- Constant Current Feed: –48 V supply voltage
- Internal Darlington power transistor
- Ring trip detection
- Current shutdown function
- Two internal relay drivers

Functions

Basic Functions

Current Feed Control

For PBX use, the Hitachi SLIC adapts the constant feed current method for short distance line use. Therefore, low power dissipation is realized by keeping the loop current Typical value at 27 mA when loop resistance RL = 50 Ω. In addition, integration of power transistors for battery feed saves mounting space on line cards.

Noise suppression circuitry insures impedance balance by improving the relative precision of the 39 Ω potential detect emitter resistor (equipped on both VBB and GND sides).

Loop Detection

The SLIC detects subscribers' hook status (on/off) and outputs it to the SCN pin.

DC loop detection:

Detects DC loop status (open or closed) using a potential detection emitter connected to a current feed circuit and outputs it to the SCN pin through a comparator.

Ring Trip Detection:

See Additional Functions

2 w–4 w Conversion

The SLIC provides 2-wire balanced to 4-wire single ended conversions preventing the 4-wire input signal from returning to the 4-wire output by using external Cx, Zx, ZBN and internal opamp circuits.

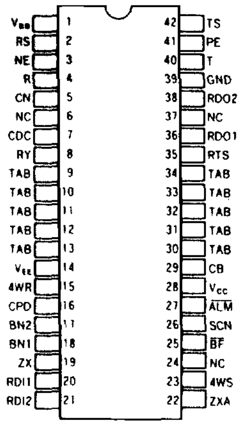
Additional Functions

Ring Trip Detection

With an externally connected CR filter, the Hitachi SLIC can detect the off-hook status of a called subscriber while ring relay is sending a ringing signal. When the subscriber goes off hook, a DC current superimposed on the ringing signal flows through the

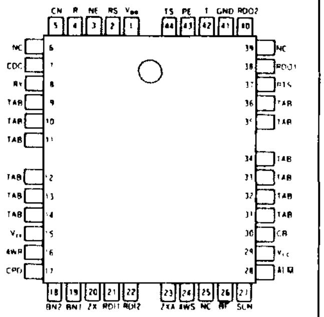
Pin Arrangement

HA16817NT



(Top View)

HA16817MP



(Top View)

HITACHI
Hitachi America, Ltd. • Hitachi Plaza • 2000 Sierra Point Pkwy. • Brisbane, CA 94005-1819 • (415) 589-8300

Current Shut-Off Function

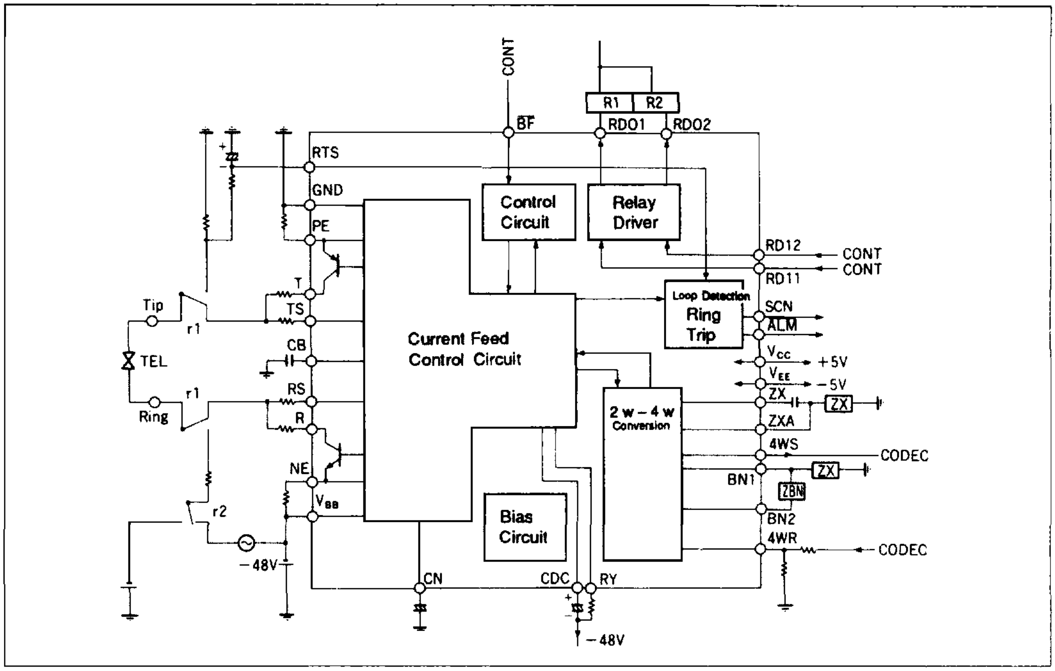
To protect PBX systems from the following problems, current feed is stopped by a command issued from the system controller to the BF pin.

- Subscriber loop line faults
- Emergency overload

Relay Drivers

The Hitachi SLIC has two internal relay drivers which drive the relay coil directly when an enable signal is sent to the RDI1 or RDI2 pin.

Block Diagram



Pin Description

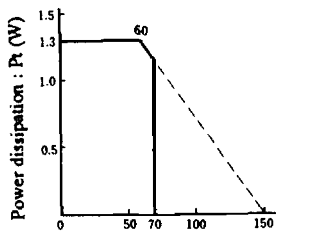
No. NT	No. MP	Name	Functional Description
1	1	V_{BB}	–48 V source input
2	2	RS	Ring-side potential detection input connected to the subscriber line through the detection resistor
3	3	NE	Ring-side NPN Darlington transistors' emitter potential detection input connected to V_{BB} (–48 V) through the emitter resistor
4	4	R	Ring-side current feed output (sink) connected to the subscriber line through the protection resistor
5	5	CN	Connected to ground through the noise filtering capacitor for power supply
6	6	NC	No connection.Must not be connected to any other pin or printed circuit
7	7	CDC	Low-pass filter capacitor connection pin for DC feedback
8	8	RY	Connected to –48 voltage source through the resistor to make a precise differential feedback loop
9-10	9-14	TAB	Heatsink pins, connected to the heatsink area fabricated on the printed board. They must not be connected to any other pin or printed circuit.
14	15	V_{EE}	–5 voltage source input
15	16	4WR	4-wire receive input which is connected to CODEC analog output through bleeder resistor for gain adjustment
16	17	CPD	Ground/battery short protection capacitor pin. Ground through capacitor.
17	18	BN2	Received signal output pin connected to BN1 through balancing impedance Z_{BN}
18	19	BN1	Analog input of differential amp. For transhybrid rejection, it's connected to the ground through termination impedance Zx, and to BN2 through impedance Z_{BN}.
19	20	ZX	DC cut capacitor and termination impedance Zx run between this terminal and ground
20	21	RDI1	TTL-level digital input for relay enable signal from the system controller
21	22	RDI2	TTL-level digital input for relay enable signal from the system controller
22	23	ZXA	Analog input of differential amp. For transmission, connected between termination impedance Zx and DC cut capacitor.
23	24	4WS	4-wire transmission output connected to CODEC
24	25	NC	No connection.Must not be connected to any other pin or printed circuit
25	26	$\overline{BF}$	TTL-level digital input for current shut-off command from the system controller. The current shut-off is enabled when input pin voltage is high.
26	27	SCN	TTL-level compatible digital output which is the common output of loop monitor and ring trip detection signals
27	28	$\overline{ALM}$	Ground detection output pin
28	29	Vcc	+5 voltage source input
29	30	CB	Connected to the ground through the phase compensation capacitor for balance amp
30-34	31-36	TAB	Heatsink pins, connected to the heatsink area fabricated on the printed board. They must not be connected to any other pin or printed circuit.
35	37	RTS	CR for ring trip detection is connected to this terminal.
36	38	RDO1	Analog output of relay driver connected to –48 voltage source through a relay coil
37	39	NC	No connection. Must not be connected to any other pin or printed circuit.
38	40	RDO2	Analog output of relay driver connected to –48 voltage source through a relay coil
39	41	GND	Ground pin
40	42	T	Tip-side current feed output (sink) connected to the subscriber line through the protection resistor
41	43	PE	Tip-side PNP Darlington transistors' emitter potential detection input connected to V_{BB} (–48 V) through the emitter resistor
42	44	TS	Ring-side potential detection input connected to the subscriber line through the detection resistor

Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Rating	Unit	Notes
Supply Voltage	V_{BB}	–60	V	
	V_{CC}	7	V	
	V_{EE}	–7	V	
Power Dissipation	P_T	1.3	W	(Note 1)
Operating Temperature	Topr	0 to +70	°C	
Storage Temperature	Tstg	–55 to +125	°C	
Junction Temperature	Tjmax	150	°C	
Input Voltage	Vin1	–0.3 to Vcc+0.3	V	Digital input pin (Note 2)
	Vin2	–5.0 to +0.3	V	RTS pin
Input Current	I_{RS}	±117	mA	Rs pin, t ≤ 2 ms
	I_{TS}	±117	mA	Ts pin, t ≤ 2 ms
Relay Driver Output Source Current	I_{RDO}	–30	mA	RDO1, RDO2 pins

Notes 1: See derating curve

2: Indicates each $\overline{BF}$, LPB, RDI1 and RDI2



Derating Curve

The absolute maximum ratings are limiting values, to be applied individually, beyond which the device may be permanently damaged. Functional operation under any of these conditions is not guaranteed. Exposing a circuit to its absolute maximum rating for extended periods of time may affect the device's reliability.

3

Recommended Operating Conditions

Item		Symbol	Condition	Min	Typ	Max	Unit
Supply Voltage		V_{BB}		–53	–48	–43	V
		V_{CC}		4.75	5	5.25	V
		V_{BE}		–5.25	–5	–4.75	V
Loop Resistance		R_L	Line resistance + Terminal resistance	50		1200	Ω
Signal Input Level	2W	V_{I2W}				3.5	dBm
	4W	V_{I4W}				1.5	dBm
ZX condition	Load impedance	R_{ZX1}	Connectable load impedance	10			kΩ
ZXA condition	Signal source impedance	R_{ZR}	Connectable signal source impedance			200	kΩ
BN1 condition	Signal source impedance	R_{BN1}	Connectable signal source impedance			50	kΩ
BN2 condition	Load impedance	R_{BN2}	Connectable load impedance	10			kΩ

Electrical Characteristics

DC Characteristics (V_{BB} = –48 V, V_{CC} = 5 V, V_{EE} = –5 V, Ta = 25°C)

Item		Symbol	Test Condition	Min	Typ	Max	Unit
Power Supply	On hook	I_{BB}	$R_L = \infty$	–4.0	–1.3	—	mA
		I_{CC}		—	6.6	12.0	mA
		I_{EE}		–5.0	–2.5	—	mA
	Off hook	I_{BBL}	R_L = 50 Ω	–9.0	–4.8	—	mA
		I_{CCL}		—	8.1	14.0	mA
		I_{EEL}		–5.0	–2.5	—	mA
Power Dissipation	On hook	P_{DC}	$R_L = \infty$	—	—	270	mW
	Off hook	P_{DCL}	R_L = 200 Ω	—	—	1300	mW
Direct Current Feed		I_{LO}	R_L = 50 Ω	24	27	31	mA
		I_{L300}	R_L = 600 Ω	24	27	31	mA
		I_{L600}	R_L = 1200 Ω	20	—	—	mA
Loop Detection Current	Off hook	I_{LTH1}		11	—	16	mA
	On hook	I_{LTH2}		6	—	11	mA
Relay Driver Output Voltage		RDV_{OH}	I_{OH} = –30 mA	–2.0	—	—	V
Ring Trip Comparator Threshold Voltage		$RTSV_{TH}$		–0.97	–0.85	–0.74	V
Input Clamp Diode		V_{FAP}	V_{BB} = 10 V	0.3	—	3	V
		V_{FAN}	I_F = 117 mA	0.3	—	3	V
		V_{FBP}		0.3	—	3	V
		V_{FBN}		0.3	—	3	V
Ground Short Protection	On	R_{GF1}	V_{BB} = –43 V	250	—	—	Ω
	Off	R_{GR3}	V_{BB} = –48 V	—	—	20	kΩ
Battery Short Protection	On	R_{BF1}	V_{BB} = –43 V	250	—	—	Ω
	Off	R_{BR3}	V_{BB} = –48 V	—	—	20	kΩ
Digital Input/Output	$\overline{BF}$	BFV_{IH}	—	2.0	—	—	V
		BFV_{IL}	—	—	—	0.8	V
		BFI_{IH}	V_{IH} = 2.0 V	–5	0	5	µA
		BFI_{IL}	V_{IL} = 0.8 V	–10	1	5	µA
	RDI1	$RD1V_{IH}$	—	2.0	—	—	V
		$RD1V_{IL}$	—	—	—	0.8	V
		$RD1I_{IH}$	V_{IH} = 2.0 V	65	100	170	µA
		$RD1I_{IL}$	V_{IL} = 0.8 V	14	40	70	µA
	RDI2	$RD2V_{IH}$	—	2.0	—	—	V
		$RD2V_{IL}$	—	—	—	0.8	V
		$RD2I_{IH}$	V_{IH} = 2.0 V	65	100	170	µA
		$RD2I_{IL}$	V_{IL} = 0.8 V	14	40	70	µA
	SCN	$SCNV_{OL}$	V_{CC} = 5.25 V I_{OL} = 1.6 mA	—	—	0.4	V
		$SCNV_{OH}$	V_{CC} = 4.75 V I_{OH} = –0.4 mA	2.4	—	—	V
	$\overline{ALM}$	$ALMV_{OL}$	V_{CC} = 5.25 V I_{OL} = 1.6 mA	—	—	0.4	V
		$ALMV_{OH}$	V_{CC} = 4.75 V I_{OH} = –0.4 mA	2.4	—	—	V

AC Characteristics (V_{BB} = –48 V, V_{CC} = 5 V, V_{EE} = –5 V, Ta = 25°C)

Item		Symbol	Test Condition	Input Level (Vrms)	Min	Typ	Max	Unit
Transmission Gain	2 w→4 w	G241	f = 1 kHz	1.16	3.55	3.85	4.15	dB
	4 w→2 w	G421	RL = 200 Ω	0.921	1.7	2.0	2.3	dB
Attenuation Distortion	2 w→4 w	GF24	f = 3.4 kHz f = 1 kHz	1.16	–0.1	—	0.1	dB
	4 w→2 w	GF42	RL = 200 Ω	0.921	–0.1	—	0.1	dB
Idle Channel Noise		NI2	RL = 200 Ω	—	—	—	–81.1	dBmop
		NI4		—	—	—	–81.1	dBmop
S/N	2 w→4 w	SN24	f = 1 kHz	1.16	53	—	—	dB
	4 w→2 w	SN42	RL = 1.2 Ω	0.921	53	—	—	dB
Impedance Balance		LB2W	f = 3.4 kHz 1 kHz RL = 1.2 kΩ	0.775	40	—	—	dB
Return Loss		LM1	f = 0.3 kHz RL = 200 Ω	1.16	20	—	—	dB
Balance Return Loss		LR	f = 3.4 kHz RL = 1.2 kΩ	0.921	23	—	—	dB
Idle Channel Noise on Alternating Current Induction		NI2AC	RL = 1.2 kΩ f = 60 Hz IAC = 6.4 mArms	—	—	—	–67	dBmop
PSRR	V_{BB}→2 w	LB2	f = 3.4 kHz	24.5 mVrms	20	—	—	dB
	V_{CC}→2 w	LC2	RL = 1.2 kΩ	24.5 mVrms	20	—	—	dB
	V_{EE}→2 w	LE2		24.5 mVrms	20	—	—	dB

Digital Input/Output Logic

SCN, ALM Output Logic Truth Table

$\overline{BF}$	RL	Status: Ground (Note 1)	Status: Ground Protection (Note 2)	SCN	$\overline{ALM}$
L	On hook	T	T	H	L
			F	H	H
		F	F	L	H
	Off hook	T	T	H	L
			F	H	H
		F	F	H	H
H	On hook	T	T	H	L
			F	L	H
		F	F	L	H
	Off hook	T	T	H	L
			F	L	H
		F	F	L	H

Notes 1 T: Ground/battery short F: No ground/battery short
2 T: Ground protection F: No ground protection

Relay Driver Truth Table

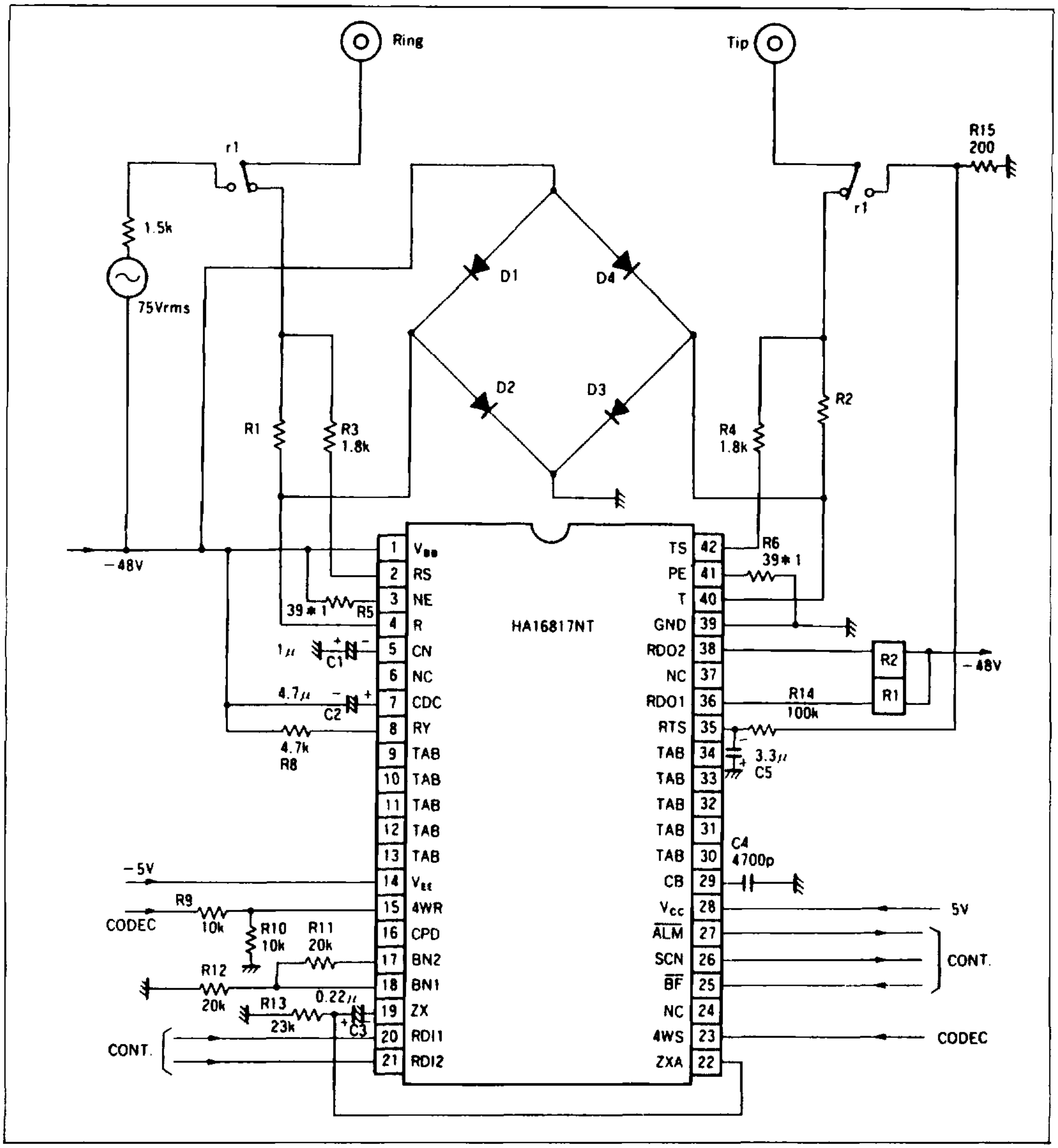
Input		Output	
RDI1	RDI2	RDO1	RDO2
H	—	H(ON)	—
L	—	L(OFF)	—
—	H	—	H(ON)
—	L	—	L(OFF)

BF Truth Table

BF	Battery Feed
H	Battery feed shut down
L	Battery feed

Application Circuit Example

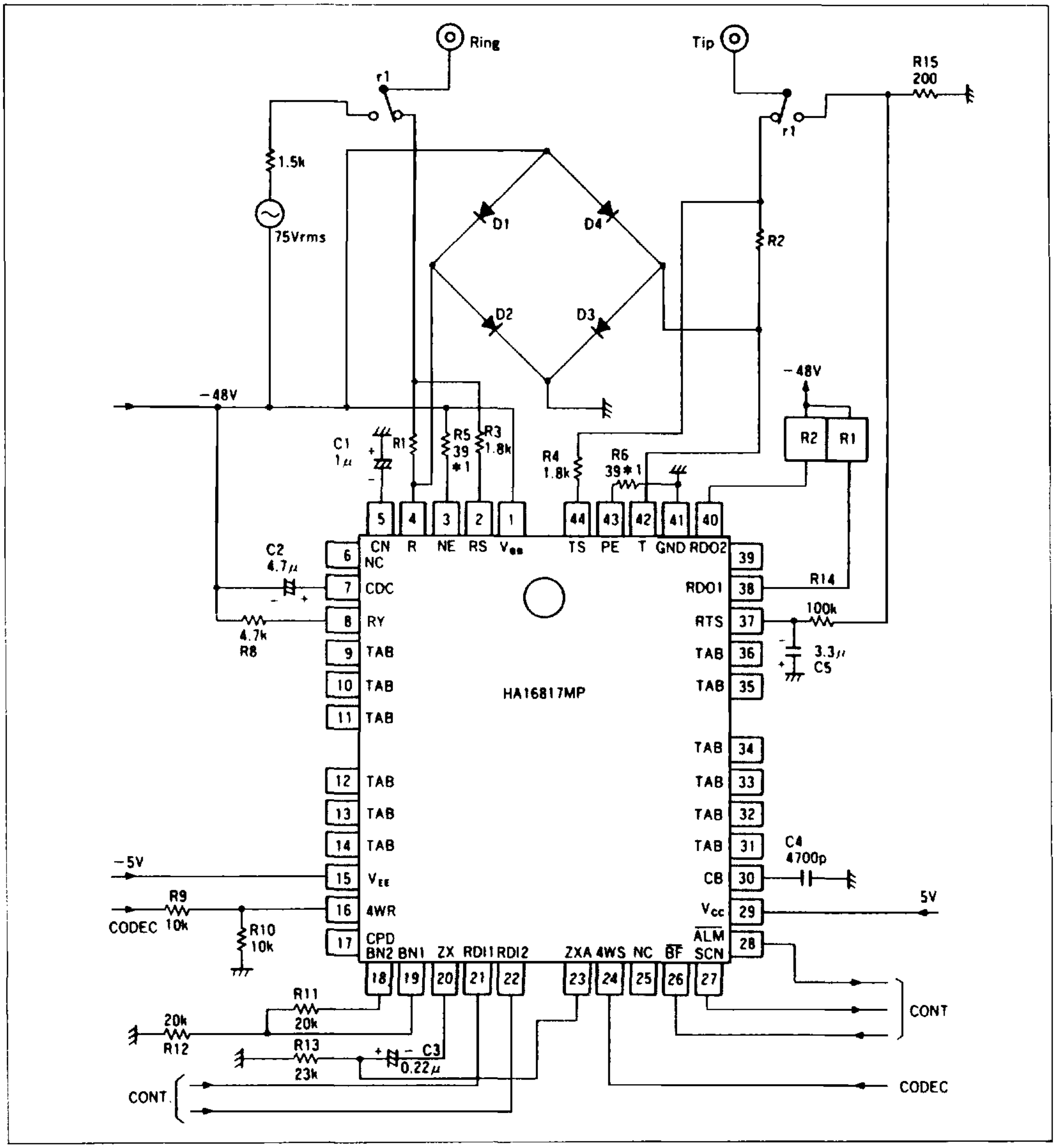
HA16817NT (Input impedance: 600Ω)



Note: Relative precision of these registers should be within ±0.1%

Figure 1

HA16817MP (Input impedance: 600Ω)



Note: Relative precision of these registers should be within ±0.1%

External Connected Components Specification Example

Table 1

Name	Spec	Accuracy	Unit	Power dissipation	Remark	Note
R1	200	5%	Ω	500 mW	For R pin lightning surge protection	1
R2	200	5%	Ω	500 mW	For T pin lightning surge protection	↓
R3	1.8	1%	kΩ	5 mW	For RS pin lightning surge protection	2
R4	1.8	1%	kΩ	5 mW	For TS pin lightning surge protection	↓
R5	39	0.1%	Ω	140 mW		3
R6	39	0.1%	Ω	140 mW		↓
R7	1.5	3%	kΩ	2.9 W	The current during ring-tripping should be considered.	4
R8	4.7	1%	kΩ	0.42 mW		5
R9	10		kΩ	0.08 mW		↓
R10	10		kΩ	0.08 mW		↓
R11	20		kΩ	0.01 mW		↓
R12	20		kΩ	0.01 mW		↓
R13	23		kΩ	0.02 mW		↓
R14	100	5%	kΩ	5.3 mW		
R15	200	3%	Ω	390 mW	The current during ring-tripping should be considered.	4
C1	1	20%	μF	—	(high drive voltage) 60	
C2	4.7	20%	μF	—	15 V	
C3	0.22	10%	μF	—	15 V	6
C4	4700	10%	pF	—	60 V	
C5	3.3	10%	μF	—	60 V	
D1	IFpeak≥1 A	—	A		For R and T pin lightning surge protections	1
D2	↓	—	A			
D3	↓	—	A			
D4	↓	—	A			

Notes

1. R1, R2 are important part in HA16817 Application Circuit because R1, R2 divided the power dissipation between HA16817.
   R1, R2 change the spec. for line feed resistance R_L.

   $$Pd = I_L \cdot [V_{BB} - I_L(R1 + R2 + R5 + R6) - I_L R_L]$$

   Example
   $50\ \Omega \le R_L \le 600\ \Omega \rightarrow R1 = R2 = 300\ \Omega$ (1/2W)
   $600\ \Omega \le R_L \le 1200\ \Omega \rightarrow R1 = R2 = 100\ \Omega$ (1/4W)

   1) The resistance should be able to withstand the lightning surge current of 200 V/R1 and 200 V/R2 during lightning surge time ≅ 2 ms.
   2) D1-D4 also should be able to withstand the lightning surge current peak.

2. The resistance should be able to withstand lightning surge current of 117 mA during surge time ≅ 2 ms.

3. When high-speed, large amplitude (more than around 7 Vo-p) impulse noise is input to the tip and ring pins, peak current 150 mA (max), flows through the resistor.

4. Delay time for relay switching must be considered when ring tripping.
   Trip delay depends on the time constant of the external filter. In this case, the estimated time is around 300 ms (max).

   Current for ring trip = (V_{BB} + VRinging) / (R7 + R15)

	R7	R15
Power dissipation when tripping	8 W	1.1 W

5. These resistances are inserted to the pass which is only for audio signals. Therefore, the level of the

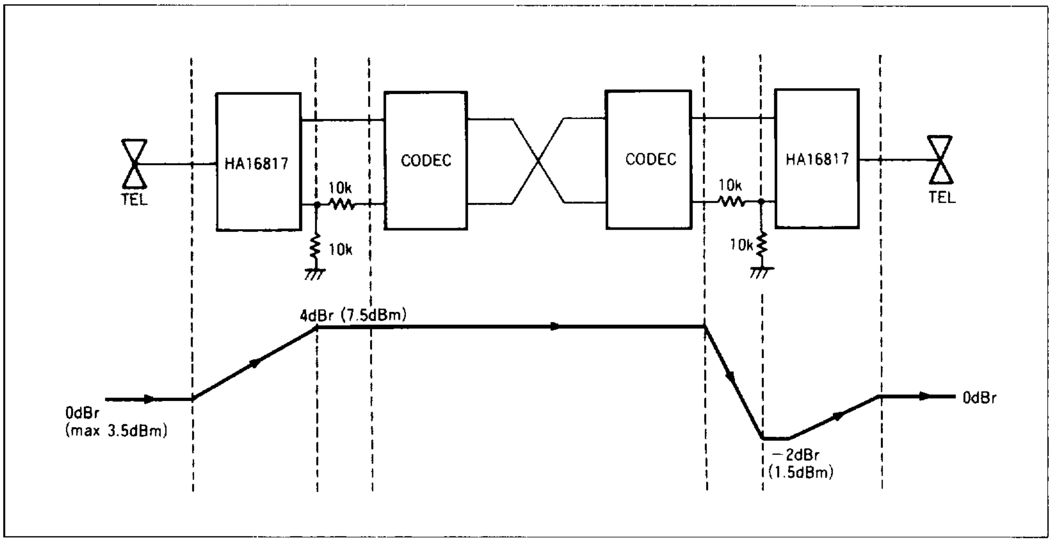


Figure 2

audio signals should be considered in power dissipation calculations. The power dissipation in the above table is calculated according to the assumed level diagram shown below.

The 4 WR to BN 2 gain is 0dB (BN 1 is a buffer amp input pin).

6. These values have a great effect on return loss and balance return loss. Therefore, capacitors whose temperature coefficients are high, such as layer-built ceramic capacitors, are not adequate for this circuit. At the ZX pin, DC0 volts appears when the hook status is "On" and −8 volts appears when the status is "Off". Verify polarity when using tantalum capacitors and the like.

Direct Current Feed

Direct current feed characteristics separate into a characteristic in a fixed current feed area and a characteristic in a fixed resistance feed area. In the fixed current feed area, the current is fed constantly by any supply voltage (V_{BB}) and line resistance. In the fixed resistance area, on the other hand, the current feed depends on the values of power supply and line resistance. The values can be obtained with the following formula.

$$I_L = |V_{BB}|/(R_L+R_f)\ (A)$$

Rf means feed resistance and is 800 Ω ± 10%. (2x400 Ω)

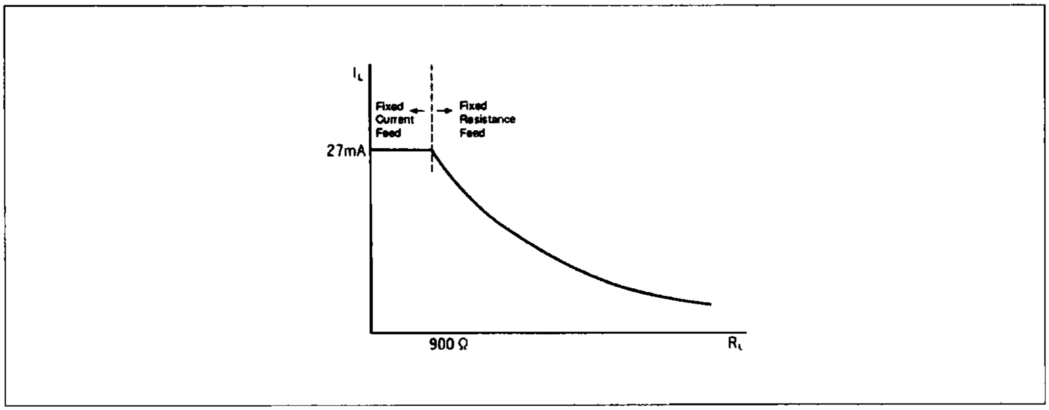


Figure 3

Termination Impedance Setting

By selecting an adequate external impedance, a termination impedance can be set at the required value. When the impedance of the Zx pin to GND is denoted Z_X, termination impedance Z_T is obtained with the following formula.

$Z_T = Z_X/K$ HA16817 K = 38.7
HA16817A K = 75.8

Be sure to insert Cx, since it is also a coupling capacitor between Zx and Z_{XA} and cannot be omitted. When using Cx only for DC out, the capacitance should be selected so that the impedance in the speech band is much lower than the termination impedance. Normally, around 0.1 µF is adequate. At the ZX pin, DC0 volts appears when the hook status is "On" and -8 volts appears when the status is "Off". Verify polarity when using electrolytic capacitors and the like.

Table 2 shows the specifications of termination impedance and external circuit constants for three countries excerpted from the CCITT Recommendation.

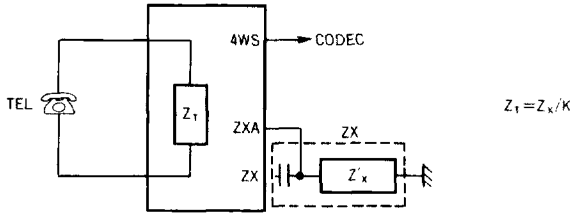
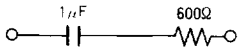
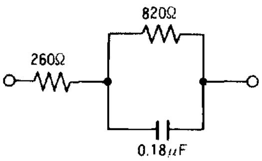
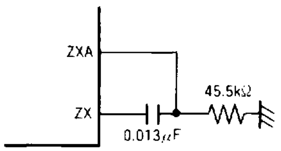
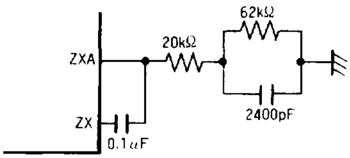
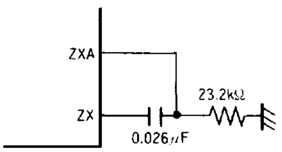
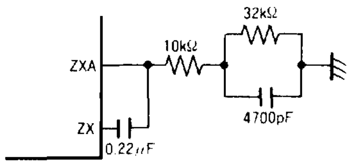


Figure 4

Table 2 Termination Impedance and External Circuit

No.	1	2
ZT		
ZX of HA16817A		
ZX of HA16817		

$Z_T = 600\Omega + 1/(j\omega \times 1\mu F)$
$Z_X = K \times Z_T = K \times 600\Omega + 1/(j\omega \times 1\mu F/K)$

HITACHI

Hitachi America, Ltd. • Hitachi Plaza • 2000 Sierra Point Pkwy. • Brisbane, CA 94005-1819 • (415) 589-8300

Balancing Network Setting

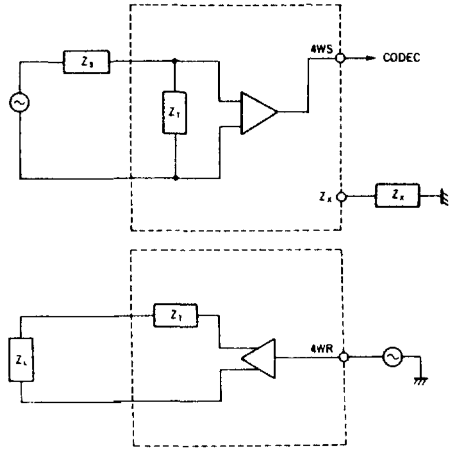
The 4 W to 4 W transfer function is

$$G44 = 4\,[Z_{BN} / (Z_{BN} + Z_{XO}) - Z_T / (Z_L + Z_T)].$$

Therefore, when $Z_L = Z_T$, the formula becomes

$$G44 = 4\,[Z_{BN} / (Z_{BN} + Z_{XO}) - 1/2].$$

$G44 \fallingdotseq 0$ can be obtained when $Z_{BN} = Z_{XO}$.



Level Diagram

The 2 W-4 W transmission gain formula is

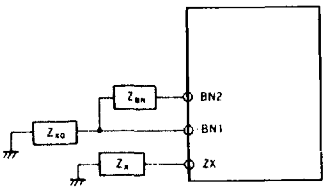
$$G24 = 20 \log |2 Z_T / (Z_S + Z_T)| + 3.85\ (\pm 0.3) \quad (dB)$$

The 4 W-2 W transmission gain formula is

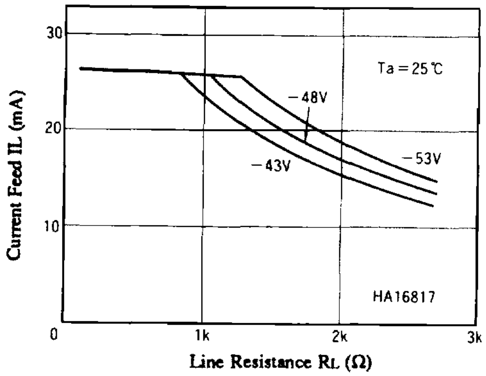
$$G42 = 20 \log |2 Z_T / (Z_S + Z_T)| + 2.0\ (\pm 0.3) \quad (dB)$$

Therefore, when $Z_T = Z_L = Z_S$, the following formulas are obtained.

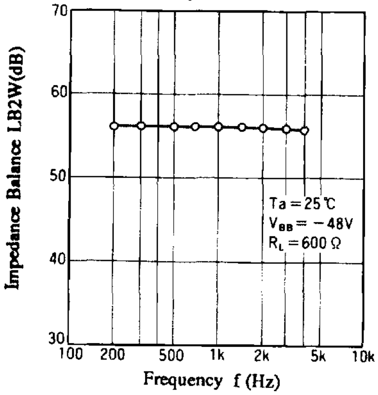
	HA16817	HA16817A	
G24	3.85 ±0.3	6.00 ±0.3	dB
G42	2.00 ±0.3	2.00 ±0.3	dB



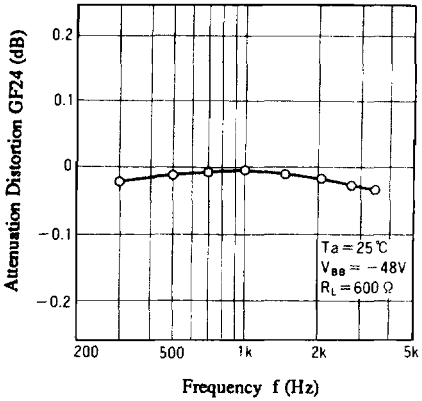
Current Feed vs. Line Resistance characteristics



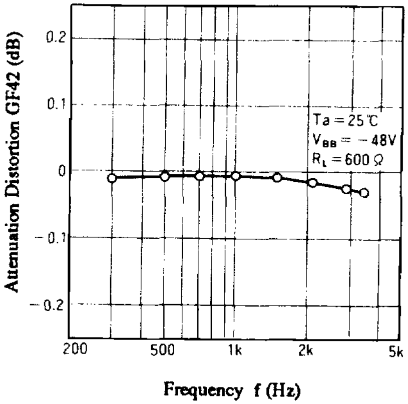
Impedance Balance vs. Frequency Characteristics



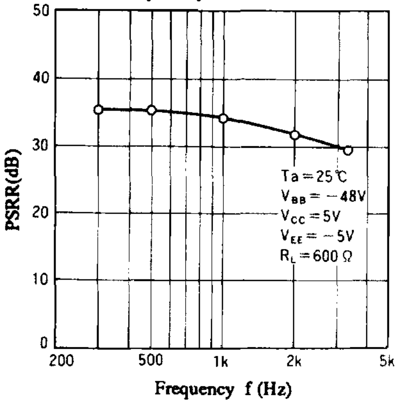
Attenuation Distortion vs. Frequency (2W→ 4W) Characteristics



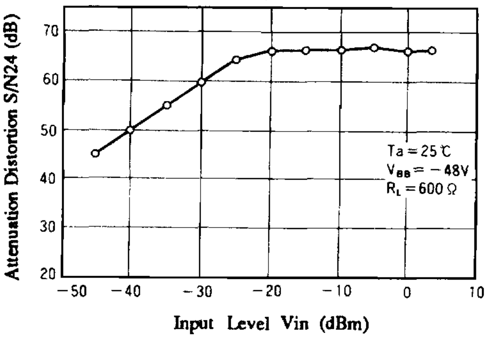
Attenuation Distortion vs. Frequency (4W→ 2W) Characteristics

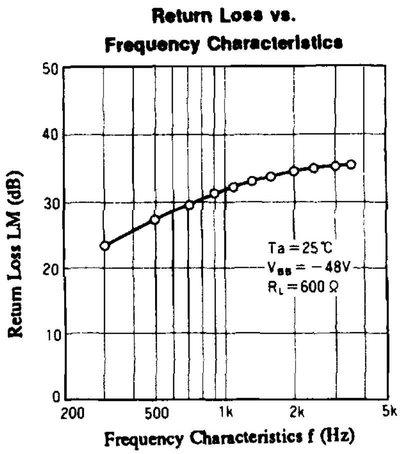


PSRR (VBB) vs. Frequency Characteristics



Attenuation Distortion vs. Input (2W→ 4W) Characteristics





Return Loss vs.
Frequency Characteristics
Return Loss LM (dB)
50
40
30
20
10
0
200
500
1k
2k
5k
Frequency Characteristics f (Hz)
Ta = 25℃
Vss = −48V
RL = 600 Ω