

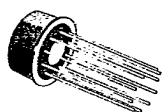


BALANCED MODULATOR

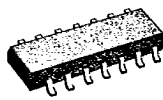
- SINGLE OR DUAL SUPPLY OPERATION
- LOW POWER CONSUMPTION
- LOW CARRIER LEAKAGE
- LOW DISTORTION
- LOW NOISE

The LS025 is a low noise linear integrated circuit, intended for use as a channel modulator and demodulator in FDM telephone equipments and as analogue AC and DC multiplier in industrial and professional applications. It features low quiescent power consumption, low distortion and intermodulation. It shows a typical carrier leakage better than 85dB throughout

the audio bandwidth. The LS025 is available in TO-100 metal case, while the hermetic gold chip (8000 series) is available in SO-14 (14-lead plastic micropackage). This last version is particularly suitable for professional and telecom applications wherever very high MTBF are required.

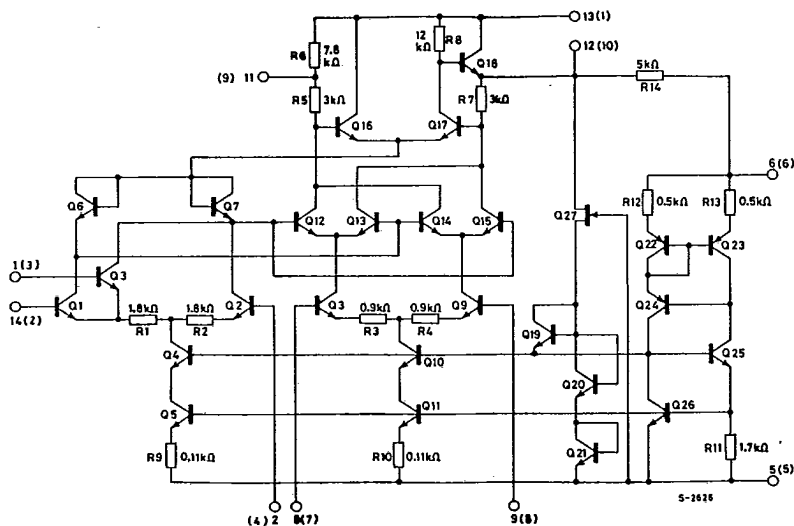


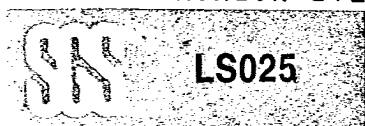
TO-100



SO-14

SCHEMATIC DIAGRAM (The pin numbers refer to the μ package version, while the numbers in brackets refer to the TO-100 version)



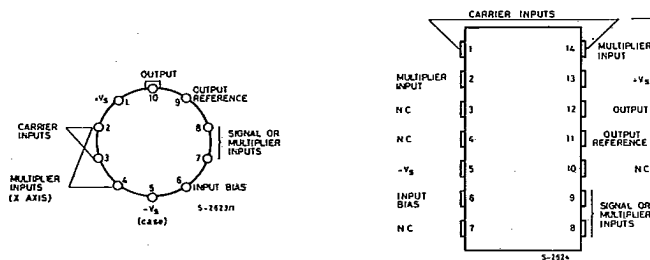


ABSOLUTE MAXIMUM RATINGS

	TO-100	μpackage
V_s Supply voltage	30 V	
ΔV_i Differential input voltage	± 5 V	
T_{op} Operating temperature	-25 to 85 °C	
P_{tot} Power dissipation at $T_{amb} = 70$ °C	520 mW	400 mW
T_{stg} Storage temperature	-65 to 150 °C	-55 to 150 °C

CONNECTION DIAGRAMS AND ORDERING NUMBERS

(top views)

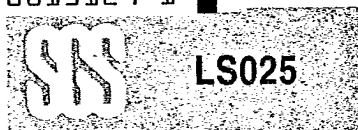


Type	TO-100	SO-14
LS 025	LS 025T	LS025M
LS 8025		LS 8025M

THERMAL DATA

	TO-100	SO-14
$R_{th j-amb}$ Thermal resistance junction ambient	max 155 °C/W	200* °C/W

* The thermal resistance is measured with the device mounted on a ceramic substrate (25 x 16 x 0.6 mm).



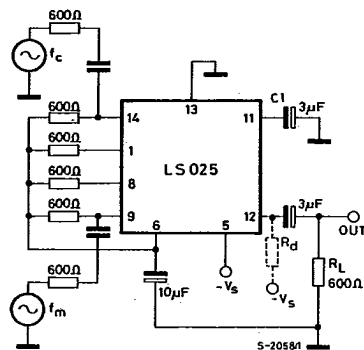
ELECTRICAL CHARACTERISTICS (Referred to the circuit of fig. 1; $T_{amb} = 25^{\circ}\text{C}$ unless otherwise specified. The pins correspond to the μ package version)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_s Supply voltage range		-12		-30	V
I_s Supply current			2	2.5	mA
I_b Input bias current	Pins 14-1 Pins 14-2 Pins 8-9		0.7 0.7 1.4	2 2 4	μA μA μA
ΔI Input offset current	Pins 14-1 Pins 14-2 Pins 8-9		50 70 100		nA nA nA
Positive input common mode voltage			4.5		V
Negative input common mode voltage			-8		V
V_o DC output voltage (pin 12)		-3.2	-3.8	-4.6	V
ΔV_o Differential output voltage (pins 11-12)			25	100	mV
V_{ref} Input biasing reference voltage (pin 6)			-7.5		V
R_i Input resistance	Pins 14-1 Pins 14-2 Pins 8-9		30 300 150		k Ω k Ω k Ω
R_o Output resistance	$f = 1 \text{ kHz}$		3	10	Ω
V_o Output voltage swing		1	1.3		V _{pp}
CMR Common mode rejection	CM signal (pins 14-1) $V = 700 \text{ mVrms}$ $f_1 = 10 \text{ kHz}$ Diff. signal (pins 8-9) $V = 350 \text{ mVrms}$ $f_2 = 40 \text{ kHz}$		98		dB
	CM signal (pins 14-2) $V = 700 \text{ mVrms}$ $f_1 = 10 \text{ kHz}$ Diff. signal (pins 8-9) $V = 350 \text{ mVrms}$ $f_2 = 40 \text{ kHz}$		86		dB
	CM signal (pins 8-9) $V = 350 \text{ mVrms}$ $f_1 = 10 \text{ kHz}$ Diff. signal (pins 14-1) $V = 175 \text{ mVrms}$ $f_2 = 40 \text{ kHz}$		80		dB
SVR Positive supply voltage rejection	$f = 1 \text{ kHz}$		33		dB
SVR Negative supply voltage rejection			80		dB

ELECTRICAL CHARACTERISTICS (continued)

Parameter	Test conditions	Min.	Typ.	Max.	Unit
K	Scale factor		3.2		V ⁻¹
G _c	Conversion gain	4.5	5	5.5	dB
ΔG _c	Conversion gain change		± 0.1		dB
	Carrier leakage	V _m = 0	-35	-50	dBv
$\frac{V_{fm}}{V(f_c \pm f_m)}$	Modulating signal leakage	-35	-50		dBmo
$\frac{V(2f_m)}{V(f_c \pm f_m)}$	2nd harmonic modulating signal leakage		-75		dBmo
$\frac{V(f_c \pm 2f_m)}{V(f_c \pm f_m)}$	2nd harmonic distortion	-60	-75		dBmo
$\frac{V(2(f_c \pm f_m))}{V(f_c \pm f_m)}$	2nd harmonic distortion	-55	-80		dBmo
$\frac{V(f_c \pm 3f_m)}{V(f_c \pm f_m)}$	3rd harmonic distortion	-60	-79		dBmo
	Low frequency thermal noise	V _m = 0 B = 100 Hz	f = 1 kHz -115	-125	dBv
	High frequency thermal noise	V _m = 0 B = 100 Hz	f = 30 kHz -127		dBv

Fig. 1 - Test and application circuit of modulator with single supply voltage



Working conditions
 $V_s = -20V$
 $f_c = 130 \text{ kHz}$
 $f_m = 25 \text{ kHz}$
 $V_o = -15 \text{ dBv } (f_c \pm f_m)$
 $V_c = -13 \text{ dBv}$
 $R_L \equiv 600 \Omega$



LS025

Fig. 2 - Carrier leakage vs. modulation signal input offset

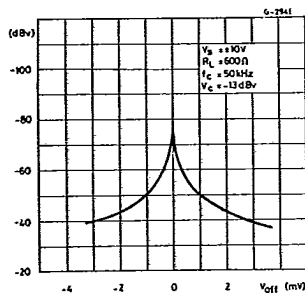


Fig. 3 - Conversion gain vs. frequency

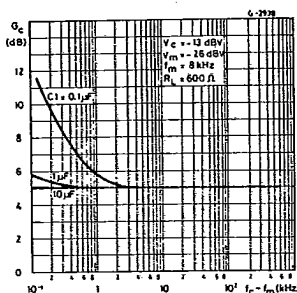


Fig. 4 - Distortion vs. output level

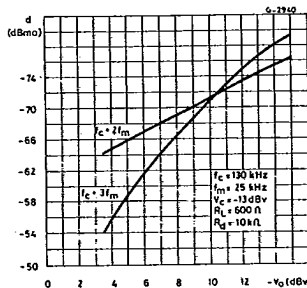


Fig. 5 - Carrier leakage adjustment circuit for system with two supply voltages

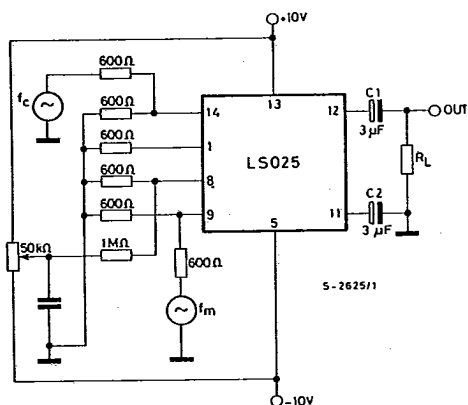
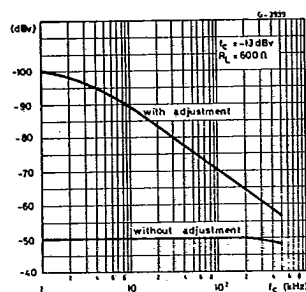


Fig. 6 - Carrier leakage vs. frequency

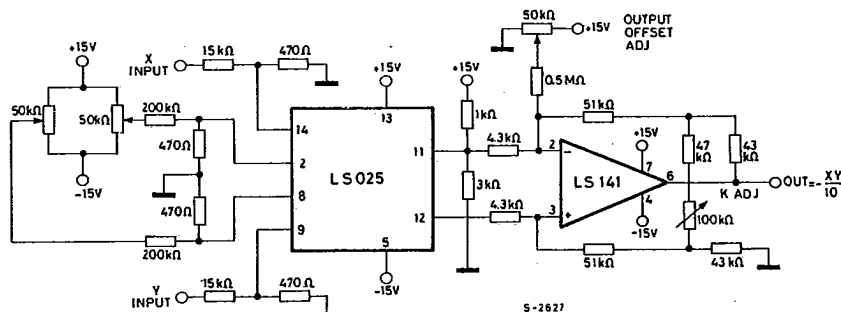




LS025

APPLICATION INFORMATION

Fig. 7 - DC multiplier



Application diagram of DC multiplier, have a scale factor $K = 0.1$. Typical linearity and leakage errors are less than 1%.
The input voltage range is $\pm 10V$.

Definition of units

dBm : power level ($10 \lg \frac{P_2}{P_1}$) is expressed in dBm when P_1 is 1 mW, therefore 0 dBm = 1 mW.

dBmo : the power is expressed in dBmo when referred to an established power level in the circuit, generally the output signal level.

e.g.: if the output level is -15 dBm and this level is chosen as reference, then 0 dBmo = -15 dBm; if another signal, i.e. the distortion measured at the same point of the circuit, is -90 dBm, then the distortion is -75 dBmo.

dBv : $20 \lg \frac{V_2}{V_1}$ when $V_1 = 775 \text{ mVrms}$.

Definition of terms

Common mode rejection : $CMR = 20 \lg \frac{V_{CM} G}{V_o}$
ratio

with G = Conversion gain with specified circuit conditions
 V_{CM} = Common mode signal level
 V_o = Output signal level at frequency = $f_2 \pm f_1$

Scale factor : $K = \frac{V_o}{V_x \cdot V_y}$

with V_x = voltage input (pins 14 - 2)
 V_y = voltage input (pins 8 - 9)



LS025

APPLICATION INFORMATION (continued)

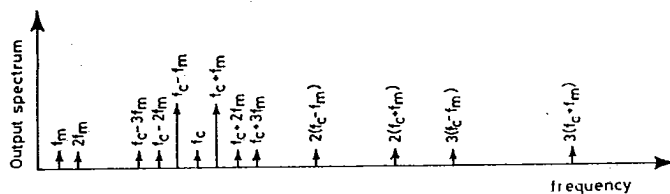
Conversion gain : $G_c = 20 \lg \frac{V_o(f_c \pm f_m)}{V_i(f_m)}$

Carrier leakage : is defined as the output voltage at carrier frequency with only the carrier applied to the input (modulating voltage = 0)

Modulating signal leakage: is defined as the output voltage, at modulating frequency, referred to fundamental carrier sidebands

M.S.L. = $20 \lg \frac{V_o(f_m)}{V_o(f_c \pm f_m)}$

Output spectrum vs. frequency



- f_c = carrier fundamental (leakage)
- f_m = mod. sig. (leakage)
- nf_m = harmonic modulating signal (leakage)
- $f_c \pm f_m$ = fundamental carrier sidebands
- $f_c \pm nf_m$ = fundamental carrier sideband harmonics
- $n(f_c \pm f_m)$ = carrier harmonic sidebands