January 2000

National Semiconductor

LM386
Low Voltage Audio Power Amplifier

General Description

The LM386 is a power amplifier designed for use in low voltage consumer applications. The gain is internally set to 20 to keep external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 will increase the gain to any value up to 200.

The inputs are ground referenced while the output is automatically biased to one half the supply voltage. The quiescent power drain is only 24 milliwatts when operating from a 6 volt supply, making the LM386 ideal for battery operation.

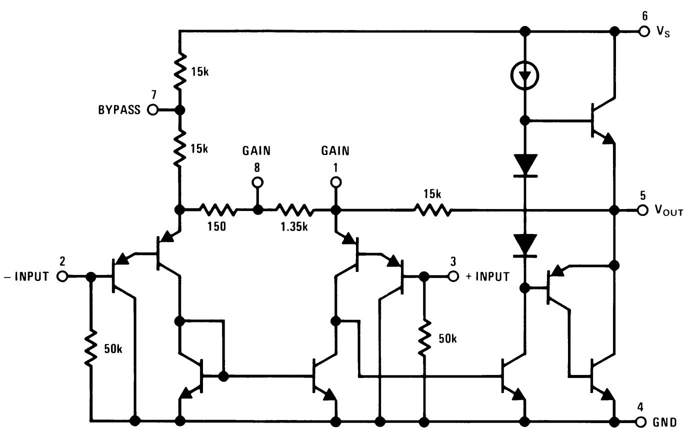
Features

- Battery operation
- Minimum external parts
- Wide supply voltage range: 4V–12V or 5V–18V
- Low quiescent current drain: 4 mA
- Voltage gains from 20 to 200
- Ground referenced input
- Self-centering output quiescent voltage
- Low distortion
- Available in 8 pin MSOP package

Applications

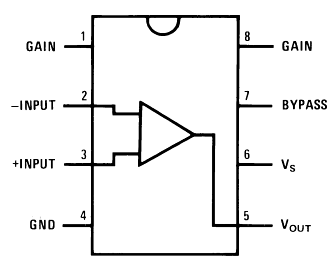
- AM-FM radio amplifiers
- Portable tape player amplifiers
- Intercoms
- TV sound systems
- Line drivers
- Ultrasonic drivers
- Small servo drivers
- Power converters

Equivalent Schematic and Connection Diagrams



DS006976-1

Small Outline,
Molded Mini Small Outline,
and Dual-In-Line Packages



DS006976-2

Top View
Order Number LM386M-1,
LM386MM-1, LM386N-1,
LM386N-3 or LM386N-4
See NS Package Number
M08A, MUA08A or N08E

 DS006976

Absolute Maximum Ratings (Note 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage	
(LM386N-1, -3, LM386M-1)	15V
Supply Voltage (LM386N-4)	22V
Package Dissipation (Note 3)	
(LM386N)	1.25W
(LM386M)	0.73W
(LM386MM-1)	0.595W
Input Voltage	±0.4V
Storage Temperature	−65˚C to +150˚C
Operating Temperature	0˚C to +70˚C
Junction Temperature	+150˚C
Soldering Information	
Dual-In-Line Package	
Soldering (10 sec)	+260˚C
Small Outline Package	
(SOIC and MSOP)	
Vapor Phase (60 sec)	+215˚C
Infrared (15 sec)	+220˚C

See AN-450 “Surface Mounting Methods and Their Effect on Product Reliability” for other methods of soldering surface mount devices.

Thermal Resistance	
θ_{JC} (DIP)	37˚C/W
θ_{JA} (DIP)	107˚C/W
θ_{JC} (SO Package)	35˚C/W
θ_{JA} (SO Package)	172˚C/W
θ_{JA} (MSOP)	210˚C/W
θ_{JC} (MSOP)	56˚C/W

Electrical Characteristics (Notes 1, 2)

T_A = 25˚C

Parameter	Conditions	Min	Typ	Max	Units
Operating Supply Voltage (V_S)					
LM386N-1, -3, LM386M-1, LM386MM-1		4		12	V
LM386N-4		5		18	V
Quiescent Current (I_Q)	V_S = 6V, V_{IN} = 0		4	8	mA
Output Power (P_{OUT})					
LM386N-1, LM386M-1, LM386MM-1	V_S = 6V, R_L = 8Ω, THD = 10%	250	325		mW
LM386N-3	V_S = 9V, R_L = 8Ω, THD = 10%	500	700		mW
LM386N-4	V_S = 16V, R_L = 32Ω, THD = 10%	700	1000		mW
Voltage Gain (A_V)	V_S = 6V, f = 1 kHz		26		dB
	10 µF from Pin 1 to 8		46		dB
Bandwidth (BW)	V_S = 6V, Pins 1 and 8 Open		300		kHz
Total Harmonic Distortion (THD)	V_S = 6V, R_L = 8Ω, P_{OUT} = 125 mW f = 1 kHz, Pins 1 and 8 Open		0.2		%
Power Supply Rejection Ratio (PSRR)	V_S = 6V, f = 1 kHz, C_{BYPASS} = 10 µF Pins 1 and 8 Open, Referred to Output		50		dB
Input Resistance (R_{IN})			50		kΩ
Input Bias Current (I_{BIAS})	V_S = 6V, Pins 2 and 3 Open		250		nA

Note 1: All voltages are measured with respect to the ground pin, unless otherwise specified.

Note 2: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

Note 3: For operation in ambient temperatures above 25˚C, the device must be derated based on a 150˚C maximum junction temperature and 1) a thermal resistance of 107˚C/W junction to ambient for the dual-in-line package and 2) a thermal resistance of 170˚C/W for the small outline package.

Application Hints

GAIN CONTROL

To make the LM386 a more versatile amplifier, two pins (1 and 8) are provided for gain control. With pins 1 and 8 open the 1.35 kΩ resistor sets the gain at 20 (26 dB). If a capacitor is put from pin 1 to 8, bypassing the 1.35 kΩ resistor, the gain will go up to 200 (46 dB). If a resistor is placed in series with the capacitor, the gain can be set to any value from 20 to 200. Gain control can also be done by capacitively coupling a resistor (or FET) from pin 1 to ground.

Additional external components can be placed in parallel with the internal feedback resistors to tailor the gain and frequency response for individual applications. For example, we can compensate poor speaker bass response by frequency shaping the feedback path. This is done with a series RC from pin 1 to 5 (paralleling the internal 15 kΩ resistor). For 6 dB effective bass boost: $R \cong 15\ k\Omega$, the lowest value for good stable operation is $R = 10\ k\Omega$ if pin 8 is open. If pins 1 and 8 are bypassed then R as low as 2 kΩ can be used. This restriction is because the amplifier is only compensated for closed-loop gains greater than 9.

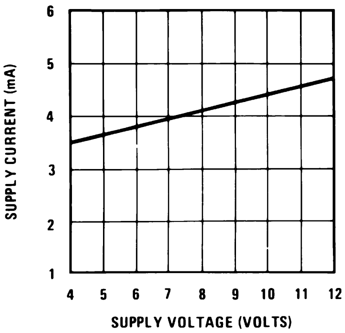
INPUT BIASING

The schematic shows that both inputs are biased to ground with a 50 kΩ resistor. The base current of the input transistors is about 250 nA, so the inputs are at about 12.5 mV when left open. If the dc source resistance driving the LM386 is higher than 250 kΩ it will contribute very little additional offset (about 2.5 mV at the input, 50 mV at the output). If the dc source resistance is less than 10 kΩ, then shorting the unused input to ground will keep the offset low (about 2.5 mV at the input, 50 mV at the output). For dc source resistances between these values we can eliminate excess offset by putting a resistor from the unused input to ground, equal in value to the dc source resistance. Of course all offset problems are eliminated if the input is capacitively coupled.

When using the LM386 with higher gains (bypassing the 1.35 kΩ resistor between pins 1 and 8) it is necessary to bypass the unused input, preventing degradation of gain and possible instabilities. This is done with a 0.1 µF capacitor or a short to ground depending on the dc source resistance on the driven input.

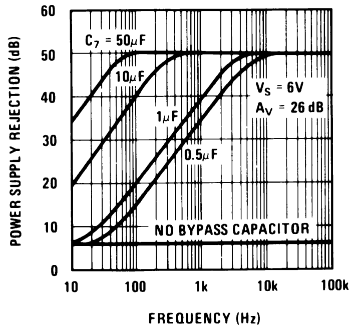
Typical Performance Characteristics

Quiescent Supply Current vs Supply Voltage



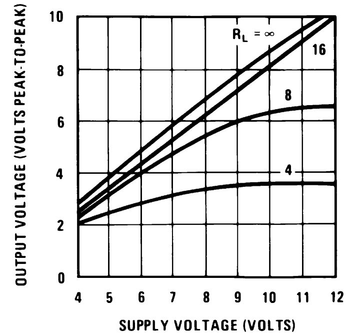
DS006976-5

Power Supply Rejection Ratio (Referred to the Output) vs Frequency



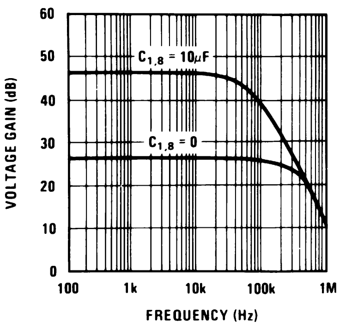
DS006976-12

Peak-to-Peak Output Voltage Swing vs Supply Voltage



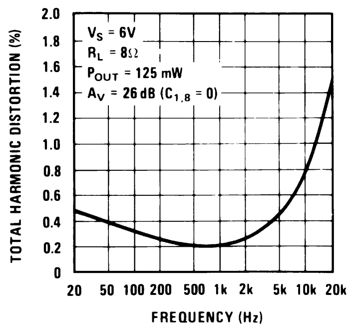
DS006976-13

Voltage Gain vs Frequency



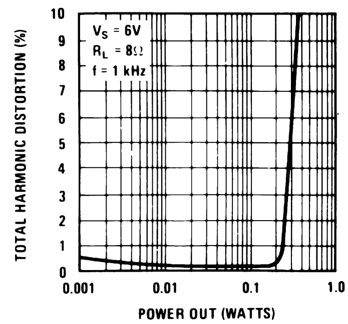
DS006976-14

Distortion vs Frequency



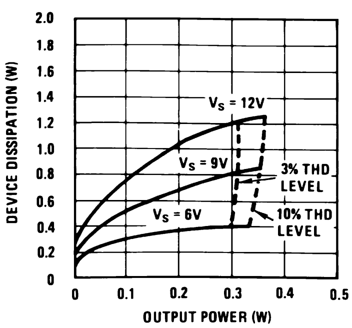
DS006976-15

Distortion vs Output Power



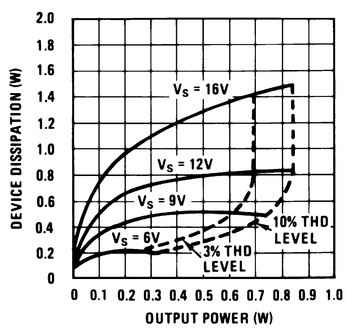
DS006976-16

Device Dissipation vs Output Power — 4Ω Load



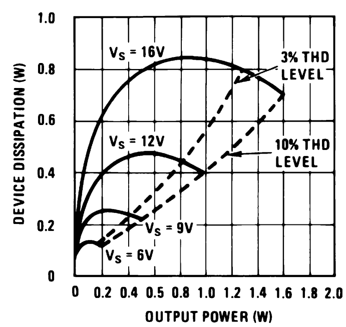
DS006976-17

Device Dissipation vs Output Power — 8Ω Load



DS006976-18

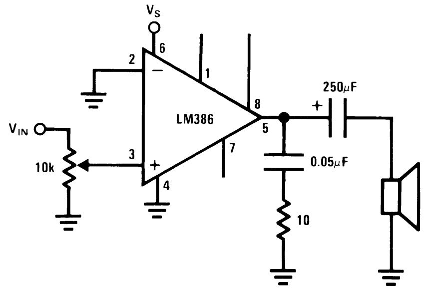
Device Dissipation vs Output Power — 16Ω Load



DS006976-19

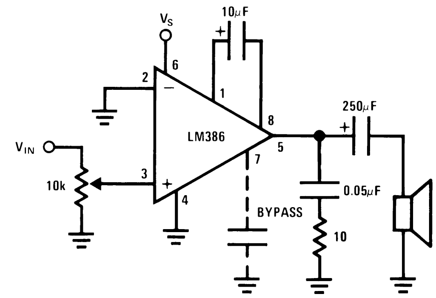
Typical Applications

Amplifier with Gain = 20 Minimum Parts



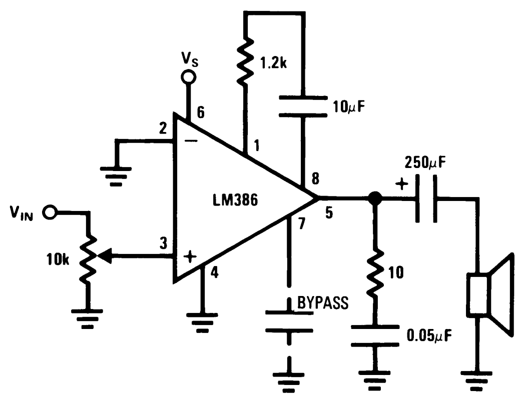
DS006976-3

Amplifier with Gain = 200



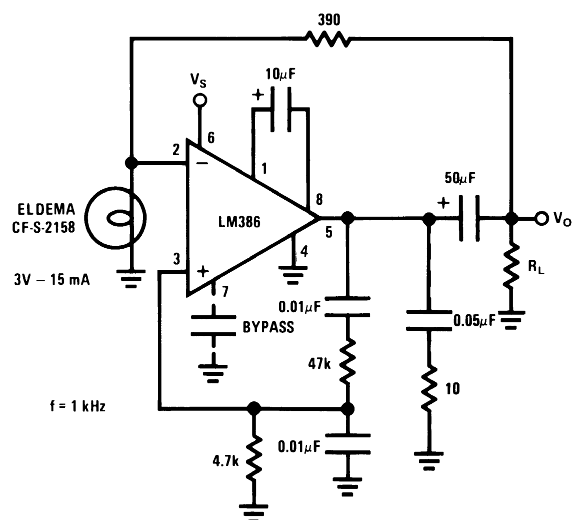
DS006976-4

Amplifier with Gain = 50



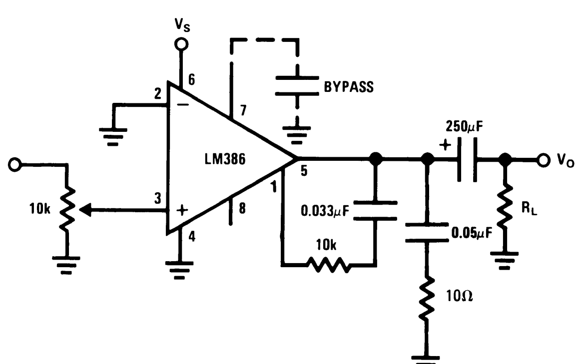
DS006976-6

Low Distortion Power Wienbridge Oscillator



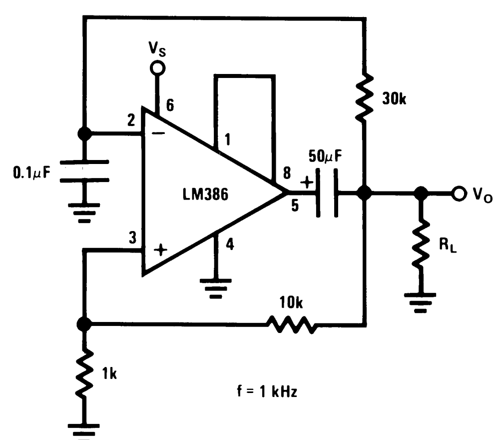
DS006976-7

Amplifier with Bass Boost



DS006976-8

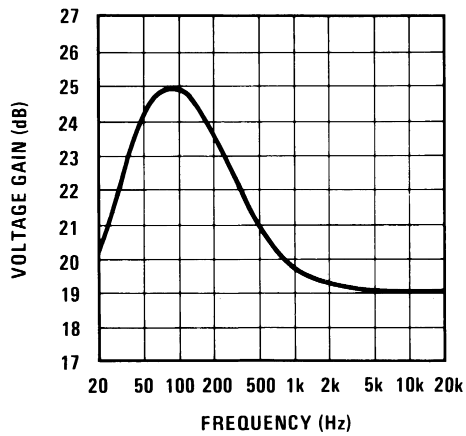
Square Wave Oscillator



DS006976-9

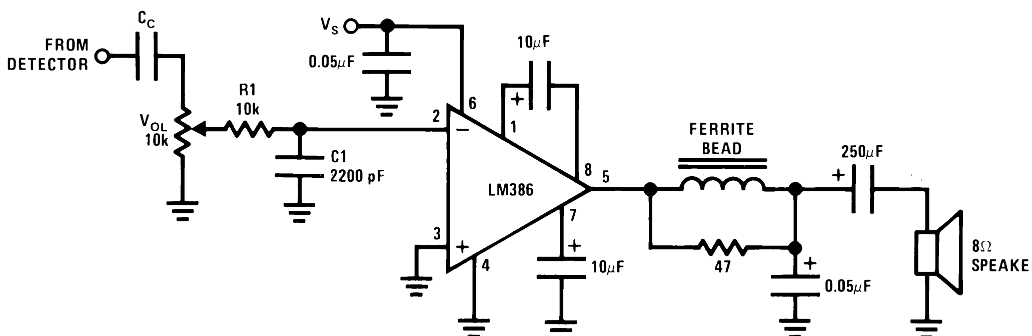
Typical Applications (Continued)

Frequency Response with Bass Boost



DS006976-10

AM Radio Power Amplifier



DS006976-11

Note 4: Twist Supply lead and supply ground very tightly.

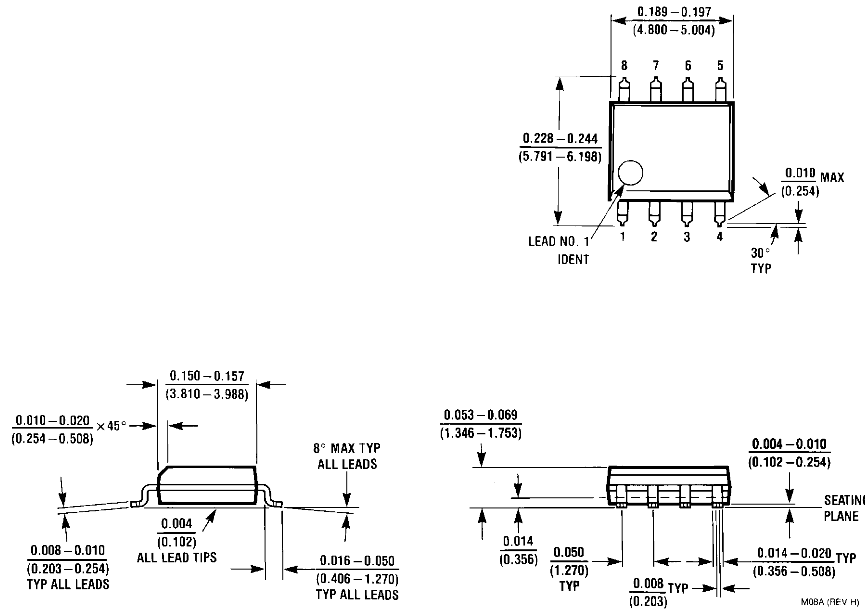
Note 5: Twist speaker lead and ground very tightly.

Note 6: Ferrite bead in Ferroxcube K5-001-001/3B with 3 turns of wire.

Note 7: R1C1 band limits input signals.

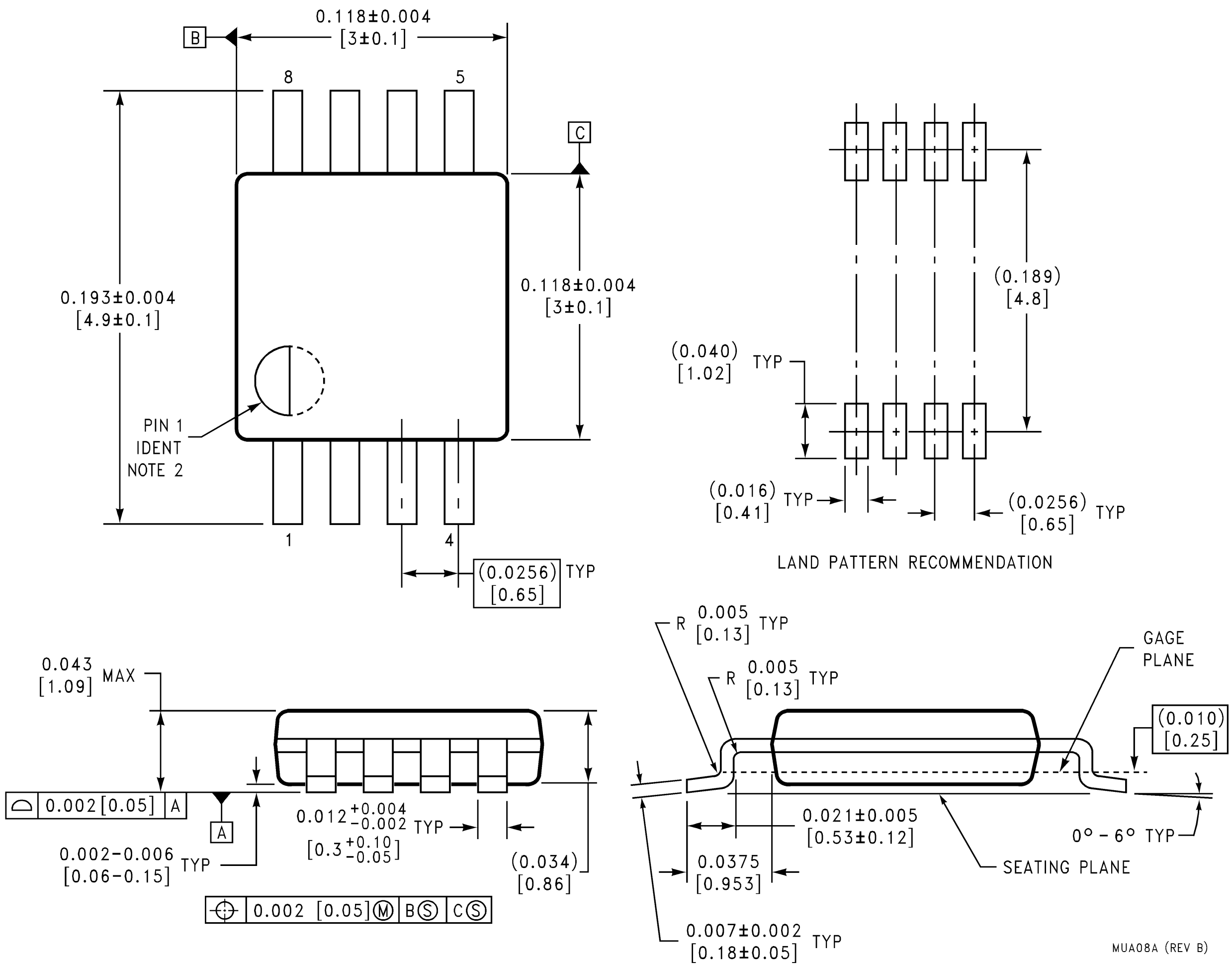
Note 8: All components must be spaced very closely to IC.

Physical Dimensions inches (millimeters) unless otherwise noted



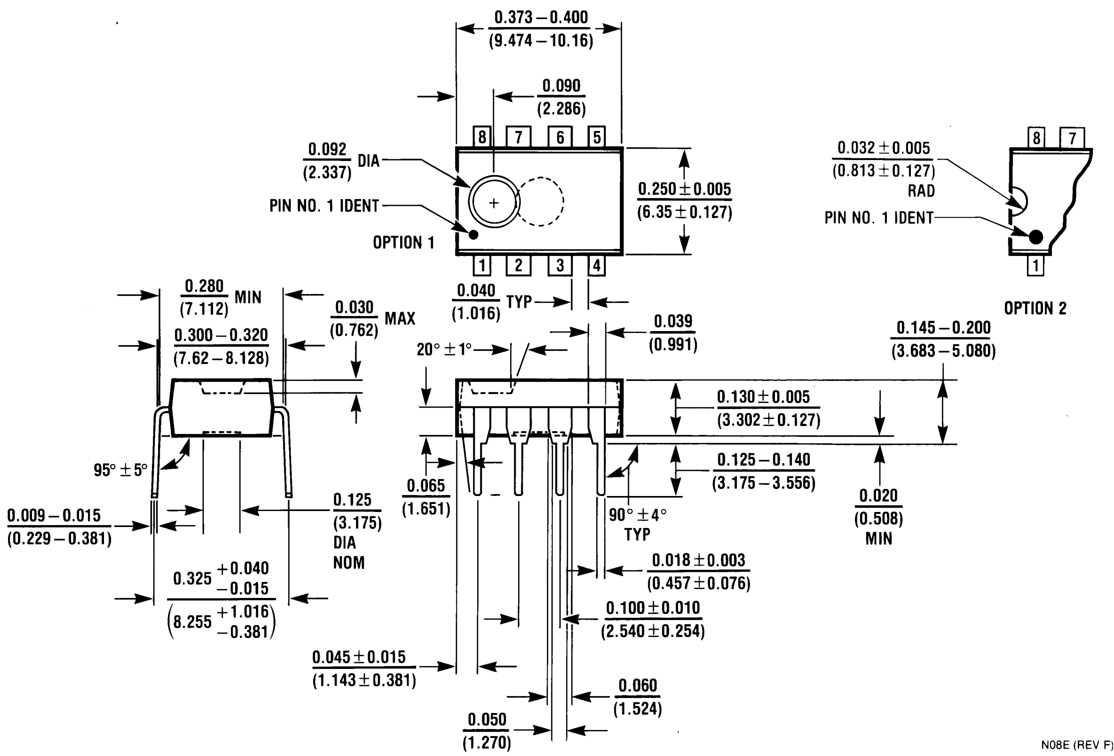
SO Package (M)
Order Number LM386M-1
NS Package Number M08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



8-Lead (0.118” Wide) Molded Mini Small Outline Package
Order Number LM386MM-1
NS Package Number MUA08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



Dual-In-Line Package (N)
Order Number LM386N-1, LM386N-3 or LM386N-4
NS Package Number N08E

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

National Semiconductor Corporation
Americas
Tel: 1-800-272-9959
Fax: 1-800-737-7018
Email: support@nsc.com

www.national.com

National Semiconductor Europe
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 1 80-530 85 85
English Tel: +49 (0) 1 80-532 78 32
Français Tel: +49 (0) 1 80-532 93 58
Italiano Tel: +49 (0) 1 80-534 16 80

National Semiconductor Asia Pacific Customer Response Group
Tel: 65-2544466
Fax: 65-2504466
Email: sea.support@nsc.com

National Semiconductor Japan Ltd.
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507

National Semiconductor

May 1998

LM741 Operational Amplifier

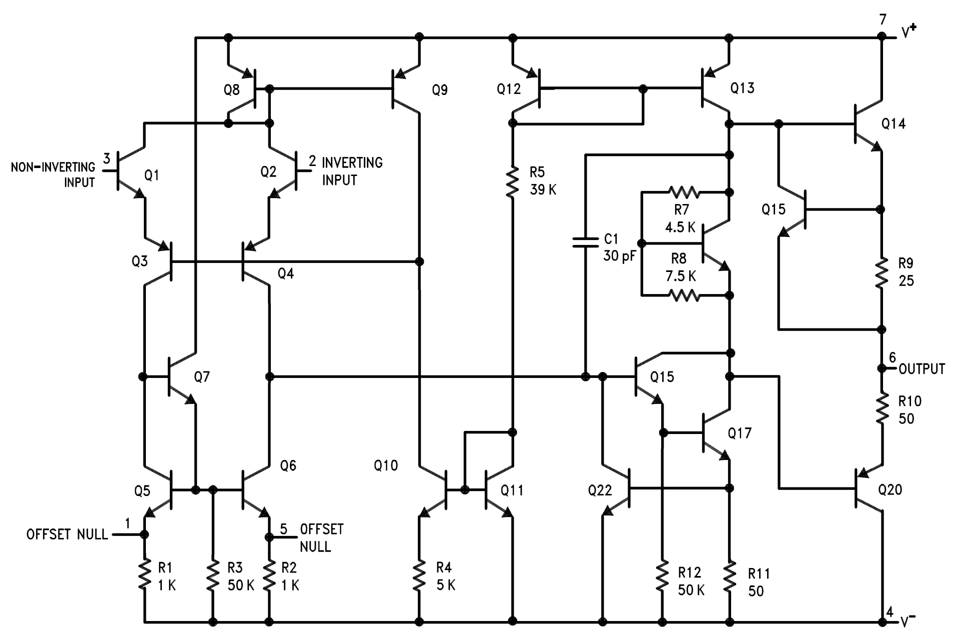
General Description

The LM741 series are general purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct, plug-in replacements for the 709C, LM201, MC1439 and 748 in most applications.

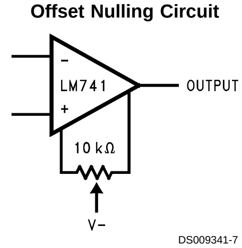
The amplifiers offer many features which make their application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

The LM741C/LM741E are identical to the LM741/LM741A except that the LM741C/LM741E have their performance guaranteed over a 0˚C to +70˚C temperature range, instead of −55˚C to +125˚C.

Schematic Diagram



Offset Nulling Circuit



Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

(Note 6)

	LM741A	LM741E	LM741	LM741C
Supply Voltage	±22V	±22V	±22V	±18V
Power Dissipation (Note 2)	500 mW	500 mW	500 mW	500 mW
Differential Input Voltage	±30V	±30V	±30V	±30V
Input Voltage (Note 3)	±15V	±15V	±15V	±15V
Output Short Circuit Duration	Continuous	Continuous	Continuous	Continuous
Operating Temperature Range	−55˚C to +125˚C	0˚C to +70˚C	−55˚C to +125˚C	0˚C to +70˚C
Storage Temperature Range	−65˚C to +150˚C	−65˚C to +150˚C	−65˚C to +150˚C	−65˚C to +150˚C
Junction Temperature	150˚C	100˚C	150˚C	100˚C
Soldering Information				
N-Package (10 seconds)	260˚C	260˚C	260˚C	260˚C
J- or H-Package (10 seconds)	300˚C	300˚C	300˚C	300˚C
M-Package				
Vapor Phase (60 seconds)	215˚C	215˚C	215˚C	215˚C
Infrared (15 seconds)	215˚C	215˚C	215˚C	215˚C
See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.				
ESD Tolerance (Note 7)	400V	400V	400V	400V

Electrical Characteristics (Note 4)

Parameter	Conditions	LM741A/LM741E			LM741			LM741C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	$T_A = 25˚C$										
	$R_S \leq 10\ k\Omega$					1.0	5.0		2.0	6.0	mV
	$R_S \leq 50\Omega$		0.8	3.0							mV
	$T_{AMIN} \leq T_A \leq T_{AMAX}$										
	$R_S \leq 50\Omega$			4.0							mV
	$R_S \leq 10\ k\Omega$						6.0			7.5	mV
Average Input Offset Voltage Drift				15							μV/˚C
Input Offset Voltage Adjustment Range	$T_A = 25˚C$, $V_S = \pm 20V$	±10				±15			±15		mV
Input Offset Current	$T_A = 25˚C$		3.0	30		20	200		20	200	nA
	$T_{AMIN} \leq T_A \leq T_{AMAX}$			70		85	500			300	nA
Average Input Offset Current Drift				0.5							nA/˚C
Input Bias Current	$T_A = 25˚C$		30	80		80	500		80	500	nA
	$T_{AMIN} \leq T_A \leq T_{AMAX}$			0.210			1.5			0.8	μA
Input Resistance	$T_A = 25˚C$, $V_S = \pm 20V$	1.0	6.0		0.3	2.0		0.3	2.0		MΩ
	$T_{AMIN} \leq T_A \leq T_{AMAX}$, $V_S = \pm 20V$	0.5									MΩ
Input Voltage Range	$T_A = 25˚C$							±12	±13		V
	$T_{AMIN} \leq T_A \leq T_{AMAX}$				±12	±13					V

Electrical Characteristics (Note 4) (Continued)

Parameter	Conditions	LM741A/LM741E			LM741			LM741C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Large Signal Voltage Gain	$T_A = 25°C$, $R_L \geq 2\ k\Omega$										
	$V_S = \pm20V$, $V_O = \pm15V$	50									V/mV
	$V_S = \pm15V$, $V_O = \pm10V$				50	200		20	200		V/mV
	$T_{AMIN} \leq T_A \leq T_{AMAX}$,										
	$R_L \geq 2\ k\Omega$,										
	$V_S = \pm20V$, $V_O = \pm15V$	32									V/mV
	$V_S = \pm15V$, $V_O = \pm10V$				25			15			V/mV
	$V_S = \pm5V$, $V_O = \pm2V$	10									V/mV
Output Voltage Swing	$V_S = \pm20V$										
	$R_L \geq 10\ k\Omega$	±16									V
	$R_L \geq 2\ k\Omega$	±15									V
	$V_S = \pm15V$										
	$R_L \geq 10\ k\Omega$				±12	±14		±12	±14		V
	$R_L \geq 2\ k\Omega$				±10	±13		±10	±13		V
Output Short Circuit Current	$T_A = 25°C$	10	25	35		25			25		mA
	$T_{AMIN} \leq T_A \leq T_{AMAX}$	10		40							mA
Common-Mode Rejection Ratio	$T_{AMIN} \leq T_A \leq T_{AMAX}$										
	$R_S \leq 10\ k\Omega$, $V_{CM} = \pm12V$				70	90		70	90		dB
	$R_S \leq 50\Omega$, $V_{CM} = \pm12V$	80	95								dB
Supply Voltage Rejection Ratio	$T_{AMIN} \leq T_A \leq T_{AMAX}$,										
	$V_S = \pm20V$ to $V_S = \pm5V$										
	$R_S \leq 50\Omega$	86	96								dB
	$R_S \leq 10\ k\Omega$				77	96		77	96		dB
Transient Response	$T_A = 25°C$, Unity Gain										
Rise Time			0.25	0.8		0.3			0.3		µs
Overshoot			6.0	20		5			5		%
Bandwidth (Note 5)	$T_A = 25°C$	0.437	1.5								MHz
Slew Rate	$T_A = 25°C$, Unity Gain	0.3	0.7			0.5			0.5		V/µs
Supply Current	$T_A = 25°C$					1.7	2.8		1.7	2.8	mA
Power Consumption	$T_A = 25°C$										
	$V_S = \pm20V$		80	150							mW
	$V_S = \pm15V$					50	85		50	85	mW
LM741A	$V_S = \pm20V$										
	$T_A = T_{AMIN}$			165							mW
	$T_A = T_{AMAX}$			135							mW
LM741E	$V_S = \pm20V$										
	$T_A = T_{AMIN}$			150							mW
	$T_A = T_{AMAX}$			150							mW
LM741	$V_S = \pm15V$										
	$T_A = T_{AMIN}$					60	100				mW
	$T_A = T_{AMAX}$					45	75				mW

Note 1: "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

Electrical Characteristics (Note 4) (Continued)

Note 2: For operation at elevated temperatures, these devices must be derated based on thermal resistance, and T_j max. (listed under “Absolute Maximum Ratings”). $T_j = T_A + (\theta_{jA} P_D)$.

Thermal Resistance	Cerdip (J)	DIP (N)	HO8 (H)	SO-8 (M)
θ_{jA} (Junction to Ambient)	100˚C/W	100˚C/W	170˚C/W	195˚C/W
θ_{jC} (Junction to Case)	N/A	N/A	25˚C/W	N/A

Note 3: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 4: Unless otherwise specified, these specifications apply for V_S = ±15V, −55˚C ≤ T_A ≤ +125˚C (LM741/LM741A). For the LM741C/LM741E, these specifications are limited to 0˚C ≤ T_A ≤ +70˚C.

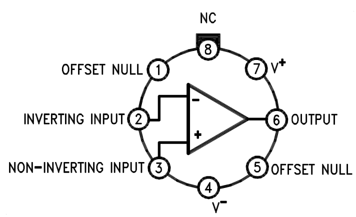
Note 5: Calculated value from: BW (MHz) = 0.35/Rise Time(µs).

Note 6: For military specifications see RETS741X for LM741 and RETS741AX for LM741A.

Note 7: Human body model, 1.5 kΩ in series with 100 pF.

Connection Diagram

Metal Can Package

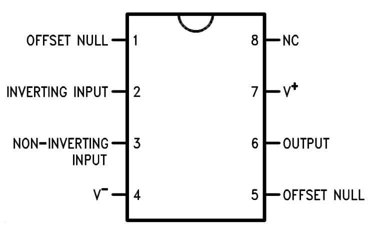


DS009341-2

Note 8: LM741H is available per JM38510/10101

Order Number LM741H, LM741H/883 (Note 8)**,**
LM741AH/883 or LM741CH
See NS Package Number H08C

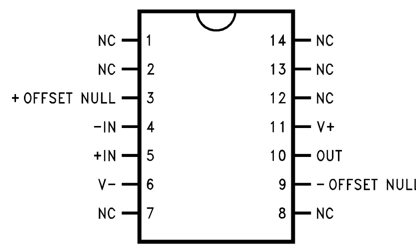
Dual-In-Line or S.O. Package



DS009341-3

Order Number LM741J, LM741J/883,
LM741CM, LM741CN or LM741EN
See NS Package Number J08A, M08A or N08E

Ceramic Dual-In-Line Package



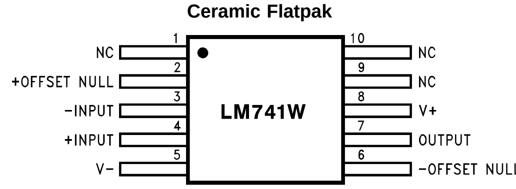
DS009341-5

Note 9: also available per JM38510/10101

Note 10: also available per JM38510/10102

Order Number LM741J-14/883 (Note 9)**,**
LM741AJ-14/883 (Note 10)
See NS Package Number J14A

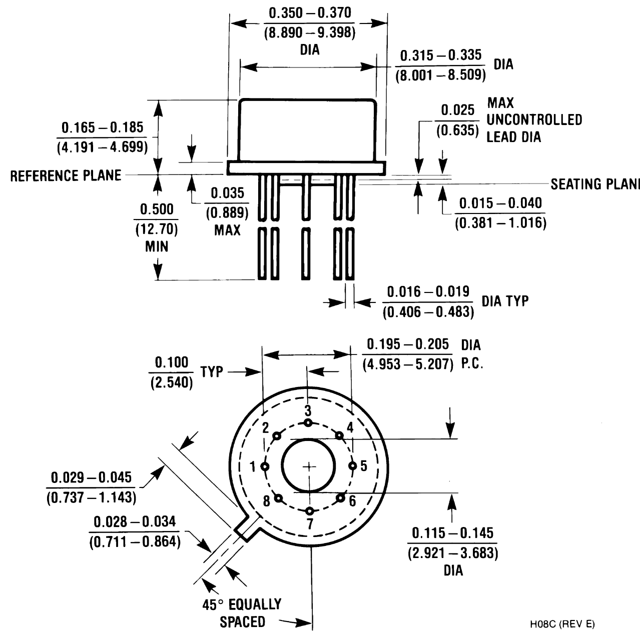
Ceramic Flatpak



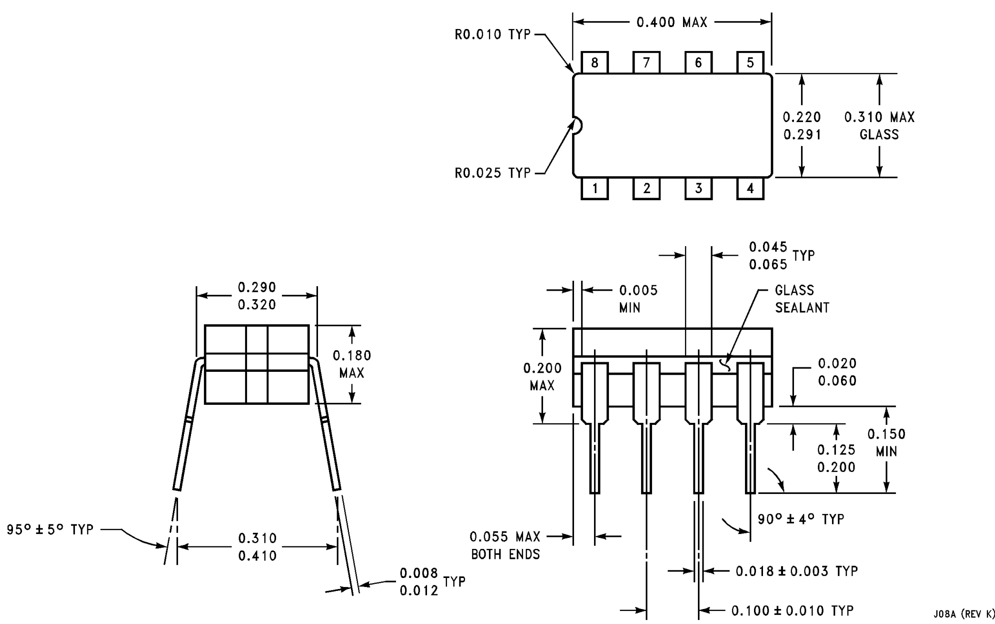
DS009341-6

Order Number LM741W/883
See NS Package Number W10A

Physical Dimensions inches (millimeters) unless otherwise noted

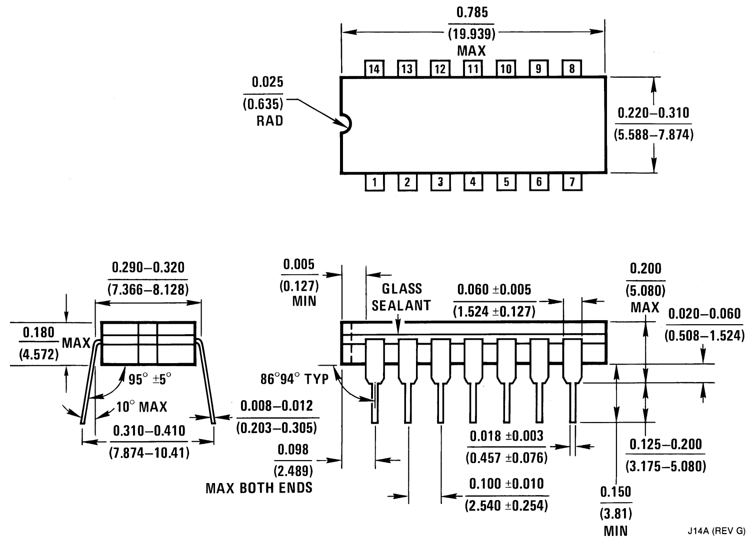


Metal Can Package (H)
Order Number LM741H, LM741H/883, LM741AH/883, LM741CH or LM741EH
NS Package Number H08C

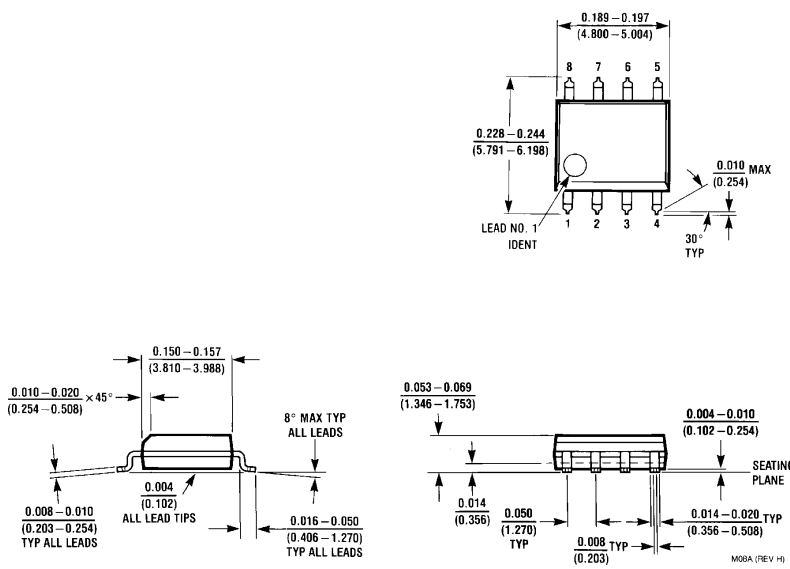


Ceramic Dual-In-Line Package (J)
Order Number LM741CJ or LM741J/883
NS Package Number J08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

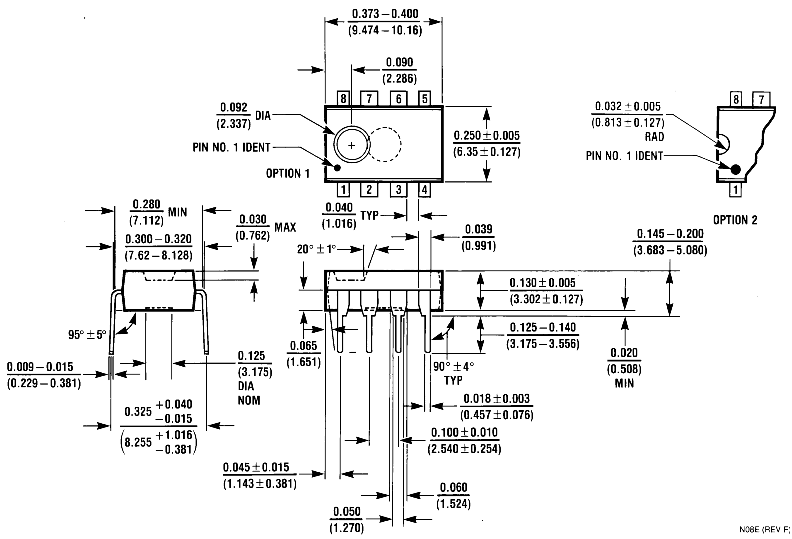


Ceramic Dual-In-Line Package (J)
Order Number LM741J-14/883 or LM741AJ-14/883
NS Package Number J14A



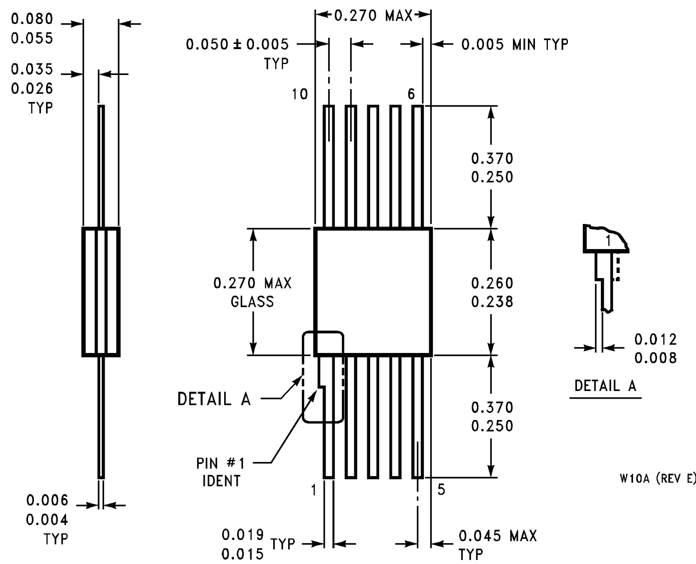
Small Outline Package (M)
Order Number LM741CM
NS Package Number M08A

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



Dual-In-Line Package (N)
Order Number LM741CN or LM741EN
NS Package Number N08E

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



10-Lead Ceramic Flatpak (W)
Order Number LM741W/883
NS Package Number W10A

National Semiconductor Corporation
Americas
Tel: 1-800-272-9959
Fax: 1-800-737-7018
Email: support@nsc.com

www.national.com

National Semiconductor Europe
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 1 80-530 85 85
English Tel: +49 (0) 1 80-532 78 32
Français Tel: +49 (0) 1 80-532 93 58
Italiano Tel: +49 (0) 1 80-534 16 80

National Semiconductor Asia Pacific Customer Response Group
Tel: 65-2544466
Fax: 65-2504466
Email: sea.support@nsc.com

National Semiconductor Japan Ltd.
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507

National Semiconductor

February 1995

LM1596/LM1496 Balanced Modulator-Demodulator

General Description

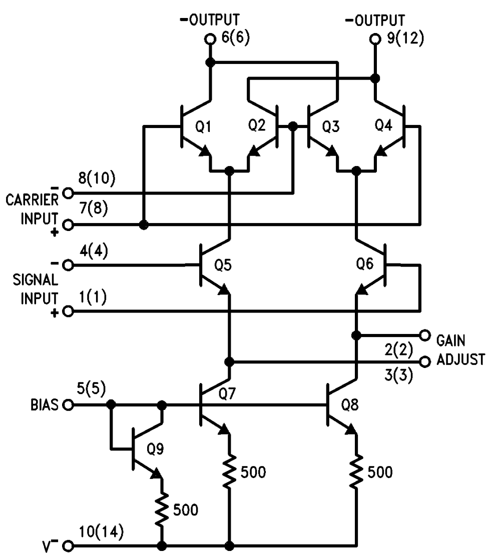
The LM1596/LM1496 are doubled balanced modulator-demodulators which produce an output voltage proportional to the product of an input (signal) voltage and a switching (carrier) signal. Typical applications include suppressed carrier modulation, amplitude modulation, synchronous detection, FM or PM detection, broadband frequency doubling and chopping.

The LM1596 is specified for operation over the −55°C to +125°C military temperature range. The LM1496 is specified for operation over the 0°C to +70°C temperature range.

Features

- Excellent carrier suppression
  65 dB typical at 0.5 MHz
  50 dB typical at 10 MHz
- Adjustable gain and signal handling
- Fully balanced inputs and outputs
- Low offset and drift
- Wide frequency response up to 100 MHz

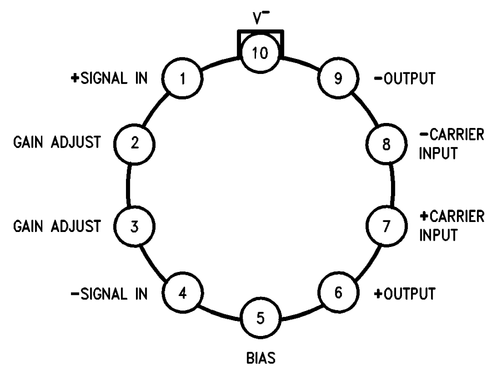
Schematic and Connection Diagrams



TL/H/7887–1

Numbers in parentheses show DIP connections.

Metal Can Package



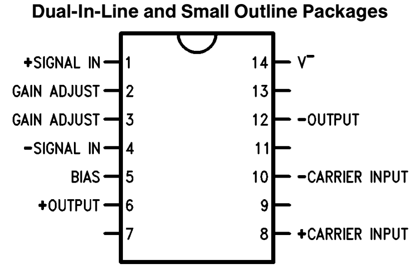
TL/H/7887–2

Top View

Note: Pin 10 is connected electrically to the case through the device substrate.

Order Number LM1496H or LM1596H
See NS Package Number H08C

Dual-In-Line and Small Outline Packages



TL/H/7887–3

Order Number LM1496M or LM1496N
See NS Package Number M14A or N14A

RRD-B30M115/Printed in U. S. A.

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Internal Power Dissipation (Note 1)	500 mW
Applied Voltage (Note 2)	30V
Differential Input Signal ($V_7 - V_8$)	±5.0V
Differential Input Signal ($V_4 - V_1$)	$\pm(5+I_5R_0)$V
Input Signal ($V_2 - V_1$, $V_3 - V_4$)	5.0V
Bias Current (I_5)	12 mA
Operating Temperature Range LM1596	−55°C to +125°C
LM1496	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

Soldering Information

- Dual-In-Line Package
  - Soldering (10 seconds) 260°C
- Small Outline Package
  - Vapor Phase (60 seconds) 215°C
  - Infrared (15 seconds) 220°C

See AN-450 "Surface Mounting Methods and their effects on Product Reliability" for other methods of soldering surface mount devices.

Electrical Characteristics (T_A = 25°C, unless otherwise specified, see test circuit)

Parameter	Conditions	LM1596			LM1496			Units
		Min	Typ	Max	Min	Typ	Max	
Carrier Feedthrough	V_C = 60 mVrms sine wave f_C = 1.0 kHz, offset adjusted		40			40		μVrms
	V_C = 60 mVrms sine wave f_C = 10 kHz, offset adjusted		140			140		μVrms
	V_C = 300 mV_{pp} square wave f_C = 1.0 kHz, offset adjusted		0.04	0.2		0.04	0.2	mVrms
	V_C = 300 mV_{pp} square wave f_C = 1.0 kHz, not offset adjusted		20	100		20	150	mVrms
Carrier Suppression	f_S = 10 kHz, 300 mVrms f_C = 500 kHz, 60 mVrms sine wave offset adjusted	50	65		50	65		dB
	f_S = 10 kHz, 300 mVrms f_C = 10 MHz, 60 mVrms sine wave offset adjusted		50			50		dB
Transadmittance Bandwidth	R_L = 50Ω Carrier Input Port, V_C = 60 mVrms sine wave f_S = 1.0 kHz, 300 mVrms sine wave		300			300		MHz
	Signal Input Port, V_S = 300 mVrms sine wave $V_7 - V_8$ = 0.5Vdc		80			80		MHz
Voltage Gain, Signal Channel	V_S = 100 mVrms, f = 1.0 kHz $V_7 - V_8$ = 0.5 Vdc	2.5	3.5		2.5	3.5		V/V
Input Resistance, Signal Port	f = 5.0 MHz $V_7 - V_8$ = 0.5 Vdc		200			200		kΩ
Input Capacitance, Signal Port	f = 5.0 MHz $V_7 - V_8$ = 0.5 Vdc		2.0			2.0		pF
Single Ended Output Resistance	f = 10 MHz		40			40		kΩ
Single Ended Output Capacitance	f = 10 MHz		5.0			5.0		pF
Input Bias Current	$(I_1 + I_4)/2$		12	25		12	30	μA
Input Bias Current	$(I_7 + I_8)/2$		12	25		12	30	μA
Input Offset Current	$(I_1 - I_4)$		0.7	5.0		0.7	5.0	μA
Input Offset Current	$(I_7 - I_8)$		0.7	5.0		5.0	5.0	μA
Average Temperature Coefficient of Input Offset Current	$(-55°C < T_A < +125°C)$		2.0					nA/°C
	$(0°C < T_A < +70°C)$					2.0		nA/°C
Output Offset Current	$(I_6 - I_9)$		14	50		14	60	μA
Average Temperature Coefficient of Output Offset Current	$(-55°C < T_A < +125°C)$		90					nA/°C
	$(0°C < T_A < +70°C)$					90		nA/°C

Electrical Characteristics (T_A = 25°C, unless otherwise specified, see test circuit) (Continued)

Parameter	Conditions	LM1596			LM1496			Units
		Min	Typ	Max	Min	Typ	Max	
Signal Port Common Mode Input Voltage Range	f_S = 1.0 kHz		5.0			5.0		V_{p-p}
Signal Port Common Mode Rejection Ratio	$V_7 - V_8$ = 0.5 Vdc		−85			−85		dB
Common Mode Quiescent Output Voltage			8.0			8.0		Vdc
Differential Output Swing Capability			8.0			8.0		V_{p-p}
Positive Supply Current	$(I_6 + I_9)$		2.0	3.0		2.0	3.0	mA
Negative Supply Current	(I_{10})		3.0	4.0		3.0	4.0	mA
Power Dissipation			33			33		mW

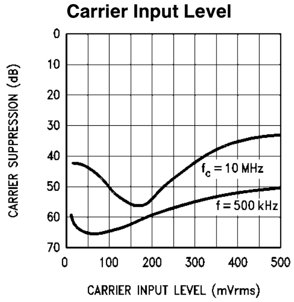
Note 1: LM1596 rating applies to case temperatures to +125°C; derate linearly at 6.5 mW/°C for ambient temperature above 75°C. LM1496 rating applies to case temperatures to +70°C.

Note 2: Voltage applied between pins 6-7, 8-1, 9-7, 9-8, 7-4, 7-1, 8-4, 6-8, 2-5, 3-5.

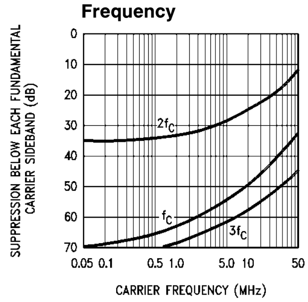
Note 3: Refer to rets1596x drawing for specifications of military LM1596H versions.

Typical Performance Characteristics

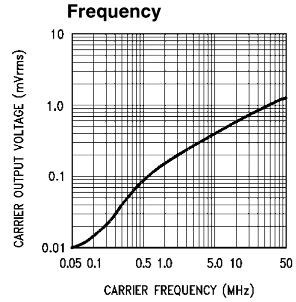
Carrier Suppression vs Carrier Input Level



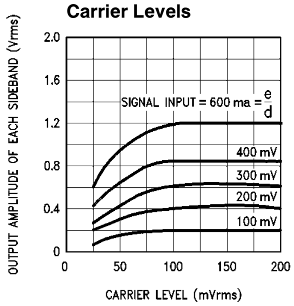
Carrier Suppression vs Frequency



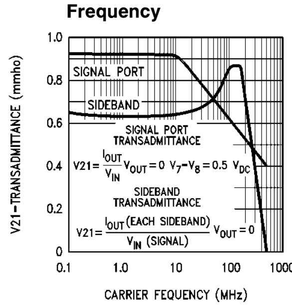
Carrier Feedthrough vs Frequency



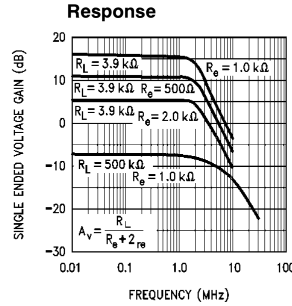
Sideband Output vs Carrier Levels



Sideband and Signal Port Transadmittances vs Frequency



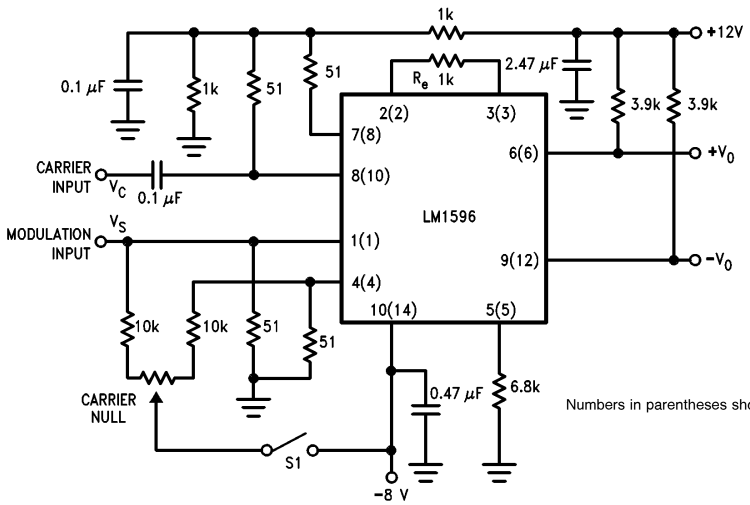
Signal-Port Frequency Response



TL/H/7887–5

Typical Application and Test Circuit

Suppressed Carrier Modulator

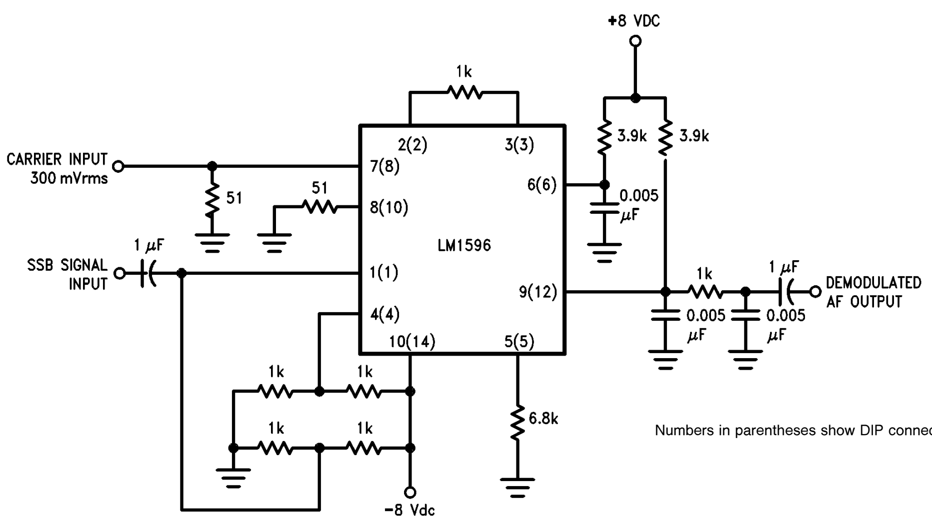


Numbers in parentheses show DIP connections.

Note: S_1 is closed for ''adjusted'' measurements.

TL/H/7887–4

SSB Product Detector



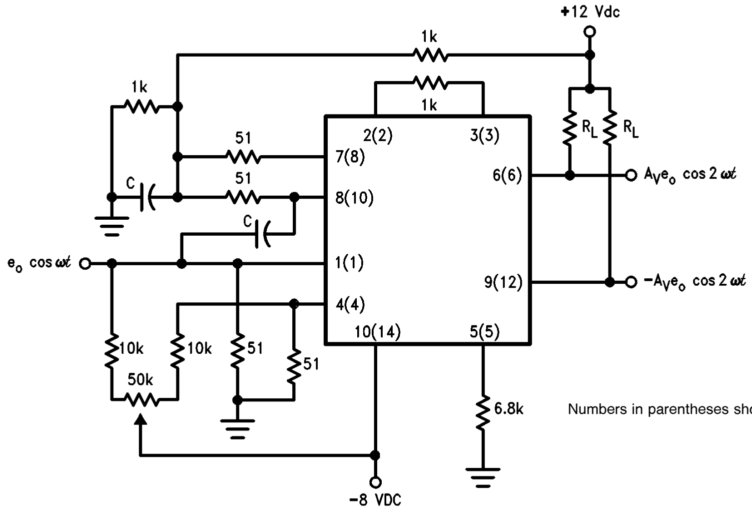
Numbers in parentheses show DIP connections.

TL/H/7887–6

This figure shows the LM1596 used as a single sideband (SSB) suppressed carrier demodulator (product detector). The carrier signal is applied to the carrier input port with sufficient amplitude for switching operation. A carrier input level of 300 mVrms is optimum. The composite SSB signal is applied to the signal input port with an amplitude of 5.0 to 500 mVrms. All output signal components except the desired demodulated audio are filtered out, so that an offset adjustment is not required. This circuit may also be used as an AM detector by applying composite and carrier signals in the same manner as described for product detector operation.

Typical Applications (Continued)

Broadband Frequency Doubler



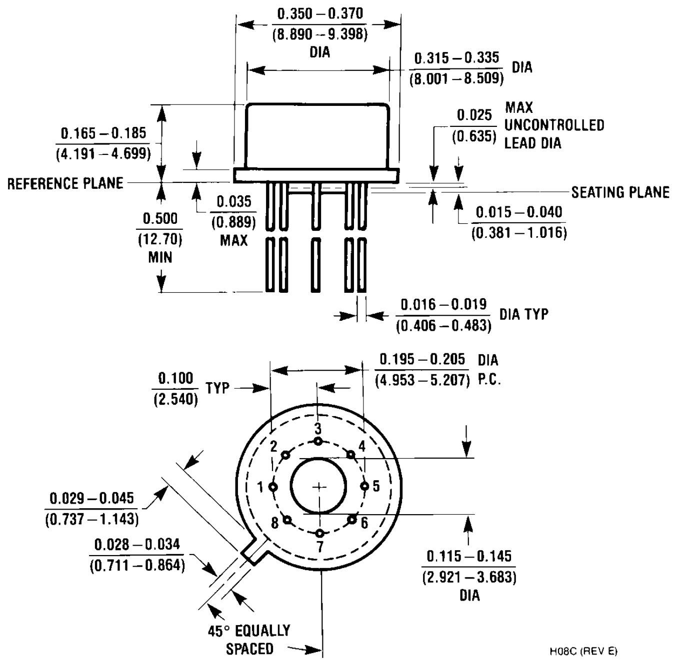
Numbers in parentheses show DIP connections.

TL/H/7887–7

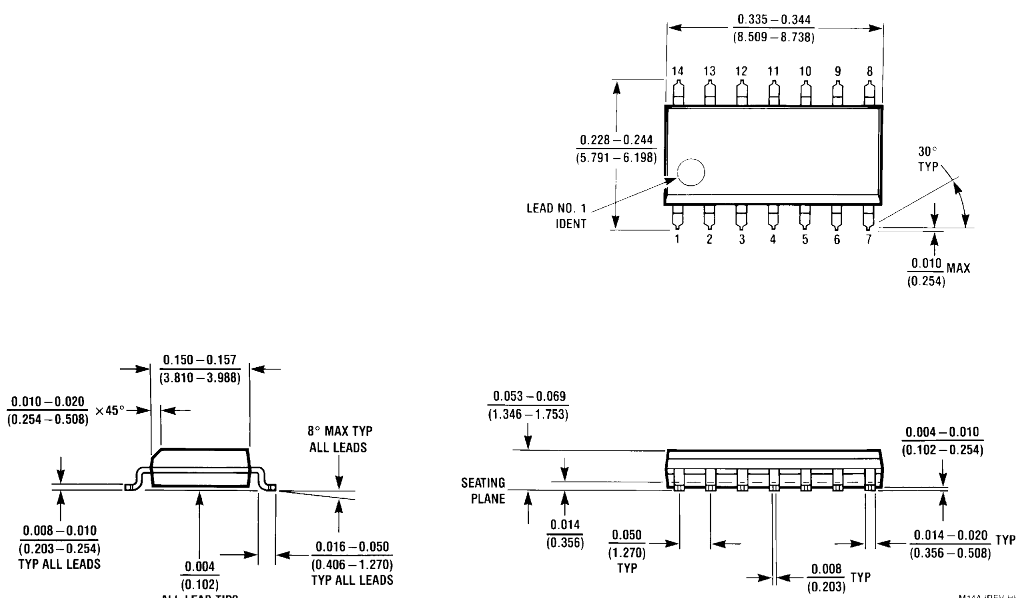
The frequency doubler circuit shown will double low-level signals with low distortion. The value of C should be chosen for low reactance at the operating frequency.

Signal level at the carrier input must be less than 25 mV peak to maintain operation in the linear region of the switching differential amplifier. Levels to 50 mV peak may be used with some distortion of the output waveform. If a larger input signal is available a resistive divider may be used at the carrier input, with full signal applied to the signal input.

Physical Dimensions inches (millimeters)

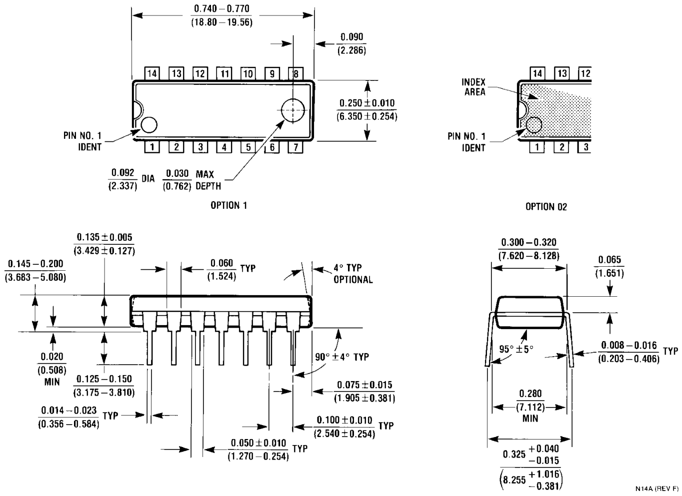


Metal Can Package (H)
Order Number LM1496H or LM1596H
NS Package Number H08C



Molded Small Outline Package (M)
Order Number LM1496M
NS Package Number M14A

Physical Dimensions inches (millimeters) (Continued)



Molded Dual-In-Line Package (N)
Order Number LM1496N
NS Package Number N14A

National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2309
Fax: 81-043-299-2408

Low Level and General Purpose Amplifiers

TYPE NO.	POLARITY	CASE	MAXIMUM RATINGS Pd (mW)	MAXIMUM RATINGS IC (mA)	MAXIMUM RATINGS VCEO (V)	HFE min	HFE max	HFE IC (mA)	HFE VCE (V)	VCE(sat) max (V)	VCE(sat) IC (mA)	fT min (MHz)	Cob max (MHz)	N.F. max (dB)
2SA641	P	TO-92B	250	50	45	100	700	0.5	3	0.3	20	60	10	-
2SA666	P	TO-92B	250	50	25	130	700 #	2	5	0.4	50	80+	-	16
2SA666A	P	TO-92B	250	50	45	130	700 #	2	5	0.4	50	80+	-	16
2SA673A	P	TO-92B	400	500	50	60	320 #	10	3	0.4	100	-	-	-
2SA721	P	TO-92B	150	50	35	180	1040 #	2	5	0.6	100	250+	-	-
2SA722	P	TO-92B	150	50	55	180	1040 #	2	5	0.6	100	250+	-	-
2SA876H	P	TO-18	350	500	50	80	240	10	3	0.5	100	110	10	-
2SA888	P	TO-92A	350	50	25	65	700 #	2	5	0.5	50	100+	2.7+	-
2SA889	P	TO-92A	350	50	45	65	700 #	2	5	0.5	50	100+	2.7+	-
2SA1015	P	TO-92B	400	150	50	70	400	2	6	0.3	100	80	7	10
2SA1715	P	TO-92B	300	200	50	90	800	1	6	0.3	100	200+	6.5+	20
2SB637K	P	TO-92B	300	100	50	160	800	2	12	0.5	100	200+	1.8	-
2SC316	N	TO-18	300	50	45	100	600	2	5	1.2	10	50+	-	-
2SC372	N	TO-92B	200	100	30	70	240 #	2	12	0.4	10	80	3.5	-
2SC373	N	TO-92B	200	100	30	200	400 #	2	12	0.4	10	80	3.5	-
2SC380	N	TO-92B	200	30	30	40	240 #	2	12	1.3	10	100	3.2	-
2SC400	N	TO-18	250	100	20	30	350 #	10	1	0.4	10	100	6	25
2SC454	N	TO-92B	200	100	30	60	320	2	12	1.1	10	230+	3.5	-
2SC536	N	TO-92B	200	100	20	40	850 #	1	6	-	-	-	6	-
2SC537	N	TO-92B	200	100	-	40	850 #	1	6	-	-	-	6	-
2SC538	N	TO-18	300	50	25	90	700 #	2	5	0.32	100	180+	4+	-
2SC538A	N	TO-18	300	50	45	90	700 #	2	5	0.32	100	180+	4+	-
2SC539	N	TO-18	300	50	25	90	700 #	2	5	0.32	100	180+	4+	4
2SC644	N	TO-92B	150	50	25	130	700 #	2	5	0.4	50	75	10	3
2SC693	N	TO-92B	100	50	-	100	850 #	1	6	-	-	90	6	-
2SC734	N	TO-92B	300	150	50	70	400 #	20	1	0.25	100	80	10	-
2SC735	N	TO-92B	300	400	30	70	240 #	100	1	0.25	100	100	10	-
2SC828	N	TO-92B	250	50	25	65	700 #	2	5	0.4	50	150+	2.5+	2+
2SC828A	N	TO-92B	250	50	45	65	700 #	2	5	0.4	50	150+	2.5+	2+
2SC858	N	TO-92B	100	50	12	100	850 #	1	6	-	-	90	6	-
2SC900	N	TO-92B	250	100	35	225	1000 #	0.5	3	0.3	100	50	5	4
2SC923	N	TO-92B	250	100	35	225	1000 #	0.5	3	0.3	100	50	5	20
2SC945	N	TO-92B	250	100	50	90	600 #	1	6	0.3	100	150	5	15
2SC1000	N	TO-92B	200	100	50	200	700 #	2	6	0.3	10	80+	2.5	10
2SC1213A	N	TO-92B	400	500	50	60	320 #	10	3	0.4	100	-	-	-
2SC1222	N	TO-92B	250	100	45	150	1000 #	0.5	3	0.3	10	60	3.2+	3
2SC1327	N	TO-92B	150	50	35	180	1040 #	2	5	0.6	100	250+	-	-
2SC1328	N	TO-92B	150	100	35	180	1040 #	2	5	0.6	100	150+	3.2+	4
2SC1330	N	TO-92B	400	100	40	60	400 #	1	6	0.5	30	50	6	-
2SC1675	N	TO-92B	250	30	30	40	180 #	1	6	0.3	10	150	2.2	-
2SC1684	N	TO-92B	250	100	25	90	650 #	2	10	0.5	100	150+	3.5+	-
2SC1685	N	TO-92B	250	100	50	90	650 #	2	10	0.5	100	150+	3.5+	-
2SC1781H	N	TO-18	350	500	50	80	240	10	3	0.5	100	150	6	-
2SC1815	N	TO-92B	400	150	50	70	700 #	6	2	0.25	100	80	3.5	-
2SC1849	N	TO-92A	350	100	25	90	650 #	2	10	0.5	100	-	-	-
2SC1850	N	TO-92A	350	100	50	90	650 #	2	10	0.5	100	-	-	-
2SC2458	N	TO-92B	200	150	50	70	700 #	6	2	0.25	100	80	3.5	-
2SC2603	N	TO-92B	300	200	50	90	800	1	6	0.3	100	200+	2.5+	15

HFE groupings available □ hfe @ 1KHz + typical value

Audio Frequency Small Signal Transistors

TYPE NO.	POLARITY	CASE	MAXIMUM RATINGS P_d (mW)	I_C (mA)	V_{CEO} (V)	H_{FE} min	H_{FE} max	I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ max (V)	I_C (mA)	f_T min (MHz)	Cob max (pF)	N.F. max (dB)
BC 107	N	TO-18	300	100	45	110	450#	2	5	0.6	100	150	6	10
BC 108	N	TO-18	300	100	20	110	800#	2	5	0.6	100	150	6	10
BC 109	N	TO-18	300	100	20	200	800#	2	5	0.6	100	150	6	4
BC 113	N	TO-106	200	50	25	200	1000	1	5	0.35	1	60	4	3
BC 114	N	TO-106	200	50	25	200	1000	1	5	0.35	1	70	4	3
BC 132	N	TO-106	200	50	25	60	300	1	10	0.35	1	40	4	–
BC 153	P	TO-106	200	100	40	50	–	10	5	0.25	10	70+	4+	1+
BC 154	P	TO-106	200	100	40	160	–	10	5	0.25	10	70+	4+	2.5
BC 167	N	TO-92B	300	100	45	110	450#	2	5	0.6	100	150	4.5	10
BC 168	N	TO-92B	300	100	20	110	800#	2	5	0.6	100	150	4.5	10
BC 169	N	TO-92B	300	100	20	200	800#	2	5	0.6	100	150	4.5	4
BC 170	N	TO-92F	300	100	20	36	600#	1	1	0.25	1	100+	4+	10
BC 171	N	TO-92F	300	100	45	125	500▲#	2	5	0.6	100	150	6	10
BC 172	N	TO-92F	300	100	25	125	900▲#	2	5	0.6	100	150	6	10
BC 173	N	TO-92F	300	100	25	125	900▲#	2	5	0.6	100	150	6	10
BC 177	P	TO-18	300	100	45	70	450#	2	5	0.3	10	150	7	10
BC 178	P	TO-18	300	100	25	70	800#	2	5	0.3	10	100	7	10
BC 179	P	TO-18	300	100	25	200	800#	2	5	0.3	10	100	7	4
BC 182	N	TO-92F	300	200	50	110	450#	2	5	0.6	100	150	5	10
BC 182L	N	TO-92B	300	200	50	110	450#	2	5	0.6	100	150	5	10
BC 183	N	TO-92F	300	200	30	110	800#	2	5	0.6	100	150	5	10
BC 183L	N	TO-92B	300	200	30	110	800#	2	5	0.6	100	150	5	10
BC 184	N	TO-92F	300	200	30	200	800#	2	5	0.6	100	150	5	4
BC 184L	N	TO-92B	300	200	30	200	800#	2	5	0.6	100	150	5	4
BC 186	P	TO-18	300	100	25	40	200	2	5	0.5	50	50	–	10
BC 204	P	TO-106	300	100	45	70	450#	2	5	0.3	10	100	4	10
BC 205	P	TO-106	300	100	20	70	800#	2	5	0.3	10	100	4	10
BC 206	P	TO-106	300	100	20	200	800#	2	5	0.3	10	100	4	4
BC 207	N	TO-106	300	100	45	110	450#	2	5	0.6	100	150	6	10
BC 208	N	TO-106	300	100	25	110	800#	2	5	0.6	100	150	6	10
BC 209	N	TO-106	300	100	25	200	800#	2	5	0.6	100	150	6	4
BC 212	P	TO-92F	300	200	50	100	400▲#	2	5	0.6	100	100	10	10
BC 212L	P	TO-92B	300	200	50	100	400▲#	2	5	0.6	100	100	10	10
BC 213	P	TO-92F	300	200	30	100	600▲#	2	5	0.6	100	100	10	10
BC 213L	P	TO-92B	300	200	30	100	600▲#	2	5	0.6	100	100	10	10
BC 214	P	TO-92F	300	200	30	200	600▲#	2	5	0.6	100	150	10	2
BC 214L	P	TO-92B	300	200	30	200	600▲#	2	5	0.6	100	150	10	2
BC 225	P	TO-106	200	100	40	90	–	10	5	0.25	10	100	8	–
BC 237	N	TO-92F	300	100	45	110	450#	2	5	0.6	100	150	4.5	10
BC 238	N	TO-92F	300	100	20	110	800#	2	5	0.6	100	150	4.5	10
BC 239	N	TO-92F	300	100	20	200	800#	2	5	0.6	100	150	4.5	4
BC 250	P	TO-92F	300	100	20	35	600#	1	1	0.4+	30	100	6	–
BC 251	P	TO-92F	300	100	45	125	900▲#	2	5	0.3	10	80	6	10
BC 252	P	TO-92F	300	100	25	125	900▲#	2	5	0.3	10	80	6	10
BC 253	P	TO-92F	300	100	25	125	900▲#	2	5	0.3	10	80	6	4
BC 257	P	TO-92B	300	100	45	70	450#	2	5	0.3	10	130	6	10
BC 258	P	TO-92B	300	100	25	70	800#	2	5	0.3	10	130	6	10
BC 259	P	TO-92B	300	100	20	200	800#	2	5	0.3	10	130	6	4
BC 260	P	TO-18	300	100	20	35	600#	1	1	0.4+	30	100	6	–
BC 261	P	TO-18	300	100	45	125	900▲#	2	5	0.3	10	100	6	10
BC 262	P	TO-18	300	100	25	125	900▲#	2	5	0.3	10	100	6	10
BC 263	P	TO-18	300	100	25	125	900▲#	2	5	0.3	10	100	6	4
BC 280	N	TO-18	360	100	40	180	600	1	5	0.7	10	–	2.8+	3
BC 307	P	TO-92F	300	100	45	70	450#	2	5	0.3	10	100	6	10
BC 308	P	TO-92F	300	100	25	70	800#	2	5	0.3	10	100	6	10
BC 309	P	TO-92F	300	100	20	200	800#	2	5	0.3	10	100	6	4

#H_{FE} groupings available ▲h_{fe} @ 1 KHz + Typical value

Audio Frequency Small Signal Transistors

TYPE NO.	POLARITY	CASE	MAXIMUM RATINGS Pd (mW)	Ic (mA)	VCEO (V)	HFE min	max	Ic (mA)	VCE (V)	VCE(SAT) max (V)	Ic (mA)	fT min (MHz)	Cob max (pF)	N.F. max (dB)
BCW 86	P	TO-92F	300	200	50	150	350	2	5	0.2	10	200	5+	–
BCX 58	N	TO-92F	450	100	32	120	630#	2	5	0.5	100	125	4.5	6
BCX 59	N	TO-92F	450	100	45	120	630#	2	5	0.5	100	125	4.5	6
BCX 78	P	TO-92F	450	100	32	120	630#	2	5	0.6	100	100	4.5	6
BCX 79	P	TO-92F	450	100	45	120	630#	2	5	0.6	100	100	4.5	6
BCY 56	N	TO-18	300	100	45	100	450	2	5	0.6	10	250+	4.5+	5
BCY 57	N	TO-18	300	100	20	200	800	2	5	0.6	10	350+	4.5+	5
BCY 58	N	TO-18	360	200	32	120	630#	2	5	0.35	10	125	6	6
BCY 59	N	TO-18	360	200	45	120	630#	2	5	0.35	10	125	6	6
BCY 66	N	TO-18	360	50	45	180	630#	2	5	0.35	10	125	6	2
BCY 67	P	TO-18	360	50	45	180	630#	2	5	0.25	10	180+	7	2
BCY 69	N	TO-18	300	100	20	450	–	2	5	0.25	10	150	8	5
BCY 70	P	TO-18	300	200	40	50	–	10	1	0.25	10	250	6	6
BCY 71	P	TO-18	350	200	45	100	600	10	1	0.25	10	200	6	2
BCY 72	P	TO-18	350	200	25	50	–	10	1	0.25	10	200	6	6
BCY 78	P	TO-18	350	200	32	120	630#	2	5	0.25	10	100	7	6
BCY 79	P	TO-18	350	200	45	120	460#	2	5	0.25	10	100	7	6
BFW 22	P	TO-18	360	100	45	250	600	1	5	0.4	50	50	6	2
BFX 92	N	TO-18	300	30	45	40	120	0.01	5	–	–	30	8	4
BFX 93	N	TO-18	300	30	45	100	300	0.01	5	–	–	30	8	3
BFY 39	N	TO-18	300	100	25	35	400#	10	10	1	10	150+	5+	–
BFY 76	N	TO-18	360	50	45	140	230	1	5	0.35	1	40	6	4
BFY 77	N	TO-18	360	50	45	200	450	1	5	0.35	1	40	6	3
CS 9011	N	TO-92A	310	100	18	29	280#	1	5	–	–	50	3.5	4.5+
CS 9014	N	TO-92A	310	100	18	60	1000#	1	5	0.5	1	50	3+	3+
CS 9015	P	TO-92A	310	100	18	60	1000#	1	5	0.5	10	50	6+	3+
CX 901	N	TO-92A	300	100	40	40	150	1	5	0.4	50	80	3.5	–
CX 904	N	TO-92A	300	100	40	80	540#	5	5	0.4	50	80	5	2+
CX 954	P	TO-92A	300	100	40	80	540#	5	5	0.4	50	80	5	2+
EN 930	N	TO-106	200	50	45	100	300	0.01	5	1	10	30	8	3
K 901	N	TO-92A	300	100	20	29	146#	1	5	0.5	10	80	3.5	–
K 9014	N	TO-92A	300	100	20	60	1000#	1	5	0.5	10	50	6	2
K 9015	P	TO-92A	300	100	20	60	1000#	1	5	0.5	10	50	6	2
L 9014	N	TO-92A	300	100	25	100	1000#	1	5	0.25	10	120+	2.4+	3
L 9015	P	TO-92A	300	100	25	100	1000#	1	5	0.25	10	120+	3.5+	3
MPS 2711	N	TO-92A	360	100	18	30	90	2	4.5	–	–	–	4	–
MPS 2712	N	TO-92A	360	100	18	75	225	2	4.5	–	–	–	12	–
MPS 2713	N	TO-92A	350	200	18	30	90	2	4.5	0.3	50	250+	2.5+	–
MPS 2714	N	TO-92A	350	200	18	75	225	2	4.5	0.3	50	250+	2.5+	–
MPS 2716	N	TO-92A	360	25	18	75	225	2	4.5	–	–	–	5	–
MPS 2923	N	TO-92A	360	100	25	90	180▲	2	10	–	–	–	12	–
MPS 2924	N	TO-92A	360	100	25	150	300▲	2	10	–	–	–	12	–
MPS 2925	N	TO-92A	360	100	25	235	470▲	2	10	–	–	–	12	–
MPS 2926	N	TO-92A	360	100	18	35	470▲#	2	10	–	–	–	3.5	–
MPS 3390	N	TO-92A	360	100	25	400	800	2	4.5	–	–	–	10	–
MPS 3391	N	TO-92A	360	100	25	250	500	2	4.5	–	–	–	10	–
MPS 3392	N	TO-92A	360	100	25	150	300	2	4.5	–	–	–	10	–
MPS 3393	N	TO-92A	360	100	25	90	180	2	4.5	–	–	–	10	–
MPS 3394	N	TO-92A	360	100	25	55	110	2	4.5	–	–	–	10	–
MPS 3395	N	TO-92A	360	100	25	150	500	2	4.5	–	–	–	10	–

#HFE groupings available ▲h_{fe} @ 1 KHz + Typical value

Audio Frequency Small Signal Transistors

TYPE NO.	POLARITY	CASE	MAXIMUM RATINGS Pd (mW)	Ic (mA)	VCEO (V)	HFE min	max	Ic (mA)	VCE (V)	VCE(SAT) max (V)	Ic (mA)	fT min (MHz)	Cob max (pF)	N.F. max (dB)
MPS 3396	N	TO-92A	360	100	25	90	500	2	4.5	–	–	–	10	–
MPS 3397	N	TO-92A	360	100	25	55	500	2	4.5	–	–	–	10	–
MPS 3398	N	TO-92A	360	100	25	55	800	2	4.5	–	–	–	10	–
MPS 3707	N	TO-92A	360	30	30	100	400	0.1	5	1	10	–	–	–
MPS 3708	N	TO-92A	360	30	30	45	660	1	5	1	10	–	–	–
MPS 3709	N	TO-92A	360	30	30	45	165	1	5	1	10	–	–	–
MPS 3710	N	TO-92A	360	30	30	90	330	1	5	1	10	–	–	–
MPS 3711	N	TO-92A	360	30	30	180	660	1	5	1	10	–	12	–
MPS 3721	N	TO-92A	360	100	18	60	660	2	10	–	–	–	3.5	–
MPS 5172	N	TO-92A	360	100	25	100	500	10	10	0.25	10	–	10	–
MPS 6512	N	TO-92A	350	100	30	50	100	2	10	0.5	50	100	3.5	2+
MPS 6513	N	TO-92A	350	100	30	90	180	2	10	0.5	50	100	3.5	2+
MPS 6514	N	TO-92A	350	100	25	150	300	2	10	0.5	50	100	3.5	2+
MPS 6515	N	TO-92A	350	100	25	250	500	2	10	0.5	50	100	3.5	2+
MPS 6516	P	TO-92A	350	100	40	50	100	2	10	0.5	50	100	4	2+
MPS 6517	P	TO-92A	350	100	40	90	180	2	10	0.5	50	100	4	2+
MPS 6518	P	TO-92A	350	100	40	150	300	2	10	0.5	50	100	4	2+
MPS 6519	P	TO-92A	350	100	25	250	500	2	10	0.5	50	100	4	2+
MPS 6520	N	TO-92A	360	100	25	200	400	2	10	0.5	50	–	3.5	3
MPS 6521	N	TO-92A	360	100	25	300	600	2	10	0.5	50	–	3.5	3
MPS 6522	P	TO-92A	360	100	25	200	400	2	10	0.5	50	–	3.5	3
MPS 6523	P	TO-92A	360	100	25	300	600	2	10	0.5	50	–	3.5	3
MPS 6565	N	TO-92A	360	200	45	40	160	10	10	0.4	10	200	3.5	–
MPS 6566	N	TO-92A	360	200	45	100	400	10	10	0.4	10	200	3.5	–
MPS 6571	N	TO-92A	360	50	20	250	1000	0.1	5	0.5	10	50	4.5	–
MPS 6573	N	TO-92A	360	100	35	200	500	10	5	0.5	10	100	12	–
MPS 6574	N	TO-92A	360	100	35	100	300#	1	5	0.5	10	100	12	–
MPS 6575	N	TO-92A	360	100	45	200	500	10	5	0.5	10	100	12	–
MPS 6576	N	TO-92A	360	100	45	100	300#	1	5	0.5	10	100	12	–
MPS 9600	N	TO-92A	300	100	12	25	300#	1	5	0.5	10	50	4	–
MPS 9601	N	TO-92A	300	100	18	25	300#	1	5	0.5	10	50	4	–
MPS 9602	N	TO-92A	300	100	30	25	300#	1	5	0.5	10	50	4	–
MPS 9630	N	TO-92A	350	100	12	45	600#	1	5	0.5	30	–	–	–
MPS 9631	N	TO-92A	350	100	18	45	600#	1	5	0.5	30	–	–	–
MPS 9632	N	TO-92A	350	100	30	45	600#	1	5	0.5	30	–	–	–
MPSA 09	N	TO-92A	350	50	50	100	600	0.1	5	0.9	10	30	5	–
MPSA 10	N	TO-92A	210	100	40	40	400	5	10	–	–	20	4	–
MPSA 20	N	TO-92A	350	100	40	40	400#	5	10	0.25	10	125	4	–
MPSA 70	P	TO-92A	350	100	40	40	400#	5	10	0.25	10	125	4	–
MPSD 06	N	TO-92A	350	50	25	50	–	50	5	0.3	50	100	–	–
MPSD 56	P	TO-92A	350	50	25	50	–	50	5	0.3	50	100	–	–
PN 930	N	TO-92A	300	100	45	100	300	0.01	5	1	10	30	8	3
PN 3548	P	TO-92A	300	100	45	100	300	0.01	5	1	10	60	8	4
PN 3565	N	TO-92A	300	50	25	150	600	1	10	0.35	1	40	4	–
PN 5138	P	TO-92A	300	50	30	50	800	0.1	10	0.3	10	30	7	–
SE 4010	N	TO-106	200	50	25	200	1000	1	10	0.35	1	60	4	3
2N 703	N	TO-18	300	50	25	40	100	10	5	0.5	10	70	6	–
2N 760	N	TO-18	500	100	45	76	333▲	1	5	1	10	50	8	–
2N 841	N	TO-18	300	1000	45	60	400	10	5	2	10	40	15	–
2N 929	N	TO-18	500	30	45	40	120	0.01	5	1	10	30	8	4
2N 929A	N	TO-18	500	30	45	40	120	0.01	5	0.5	10	45	6	4

#HFE groupings available ▲h_{fe} @ 1 KHz + Typical value

Audio Frequency Small Signal Transistors

TYPE NO.	POLARITY	CASE	MAXIMUM RATINGS P_d (mW)	I_C (mA)	V_{CEO} (V)	H_{FE} min	max	I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ max (V)	I_C (mA)	f_T min (MHz)	Cob max (pF)	N.F. max (dB)
2N 930	N	TO-18	500	30	45	100	300	0.01	5	1	10	30	8	3
2N 930A	N	TO-18	500	30	45	100	300	0.01	5	0.5	10	45	6	3
2N 2586	N	TO-18	300	100	45	120	360	0.01	5	0.5	10	45	7	3
2N 2711	N	TO-92B	200	100	18	30	90	2	4.5	–	–	–	12	2.8+
2N 2712	N	TO-92B	200	100	18	75	225	2	4.5	–	–	–	12	2.8+
2N 2714	N	TO-92B	200	100	18	75	225	2	4.5	0.3	50	–	–	–
2N 2716	N	TO-92B	200	100	18	75	225	2	4.5	–	–	–	5	–
2N 2923	N	TO-92B	200	100	25	90	180▲	2	10	–	–	–	12	–
2N 2924	N	TO-92B	200	100	25	150	300▲	2	10	–	–	–	12	–
2N 2925	N	TO-92B	200	100	25	235	470▲	2	10	–	–	–	12	–
2N 2926	N	TO-92B	200	100	18	35	470▲	2	10	–	–	–	12	–
2N 3390	N	TO-92B	200	100	25	400	800	2	4.5	–	–	–	10	–
2N 3391	N	TO-92B	200	100	25	250	500	2	4.5	–	–	120+	10	–
2N 3391A	N	TO-92B	200	100	25	250	500	2	4.5	–	–	120+	10	5
2N 3392	N	TO-92B	200	100	25	150	300	2	4.5	–	–	120+	10	–
2N 3393	N	TO-92B	200	100	25	90	180	2	4.5	–	–	120+	10	–
2N 3394	N	TO-92B	200	100	25	55	110	2	4.5	–	–	120+	10	–
2N 3395	N	TO-92B	200	100	25	150	500	2	4.5	–	–	–	10	–
2N 3396	N	TO-92B	200	100	25	90	500	2	4.5	–	–	–	10	–
2N 3397	N	TO-92B	200	100	25	55	500	2	4.5	–	–	–	10	–
2N 3398	N	TO-92B	200	100	25	55	800	2	4.5	–	–	–	10	–
2N 3547	P	TO-18	400	100	60	100	500	1	5	1	10	45	8	5
2N 3548	P	TO-18	400	100	45	100	300	0.01	5	1	10	60	8	4
2N 3549	P	TO-18	400	100	60	100	500	0.01	5	1	10	60	8	4
2N 3550	P	TO-18	400	100	45	200	600	0.01	5	0.5	5	60	8	4
2N 3565	N	TO-106	200	50	25	150	600	1	10	0.35	1	40	4	–
2N 3691	N	TO-106	200	50	25	40	160	10	1	0.7	10	200	6	–
2N 3692	N	TO-106	200	50	25	100	400	10	1	0.7	10	200	6	–
2N 3707	N	‾O-92B	360	200	30	100	400	0.1	5	1	10	–	–	5
2N 3708	N	TO-92B	360	200	30	45	660	1	5	1	10	–	–	–
2N 3709	N	TO-92B	360	200	30	45	165	1	5	1	10	–	–	–
2N 3710	N	TO-92B	360	200	30	90	330	1	5	1	10	–	–	–
2N 3711	N	TO-92B	360	200	30	180	660	1	5	1	10	–	–	–
2N 3721	N	TO-92B	200	100	18	60	660	2	10	1	100	100	12	–
2N 3843	N	TO-92B	200	100	30	20	40	2	4.5	1	10	60	4	10.2
2N 3843A	N	TO-92B	200	100	30	20	40	2	4.5	1	10	60	4	8.5
2N 3844	N	TO-92B	200	100	30	35	70	2	4.5	1	10	90	4	10.2
2N 3844A	N	TO-92B	200	100	30	35	70	2	4.5	1	10	90	4	8.5
2N 3845	N	TO-92B	200	100	30	60	120	2	4.5	1	10	120	4	10.2
2N 3845A	N	TO-92B	200	100	30	60	120	2	4.5	1	10	120	4	8.5
2N 3858	N	TO-92B	200	100	30	60	120	2	4.5	0.125	10	90	4	–
2N 3859	N	TO-92B	200	100	30	100	200	2	4.5	0.125	10	90	4	–
2N 3860	N	TO-92B	200	100	30	150	300	2	4.5	0.125	10	90	4	–
2N 3900	N	TO-92B	360	100	18	250	500	2	4.5	–	–	160+	12	–
2N 3901	N	TO-92B	360	100	18	350	700	2	4.5	–	–	200+	10	–
2N 3962	P	TO-18	360	200	60	100	300	0.01	5	0.25	10	40	6	3
2N 3964	P	TO-18	360	200	45	250	500	0.01	5	0.25	10	50	6	2
2N 4058	P	TO-92B	360	100	30	100	400	0.1	5	0.7	10	–	–	5
2N 4059	P	TO-92B	360	100	30	45	660	1	5	0.7	10	–	–	–
2N 4060	P	TO-92B	360	100	30	45	165	1	5	0.7	10	–	–	–
2N 4061	P	TO-92B	360	100	30	90	330	1	5	0.7	10	–	–	–
2N 4062	P	TO-92B	360	100	30	180	660	1	5	0.7	10	–	–	–
2N 4248	P	TO-106	200	100	40	50	–	0.1	5	0.25	10	40	6	–
2N 4249	P	TO-106	200	100	60	100	300	0.1	5	0.25	10	40	6	3
2N 4250	P	TO-106	200	100	40	250	700	0.1	5	0.25	10	50	6	2

#H_{FE} groupings available ▲h_{fe} @ 1 KHz + Typical value

Audio Frequency Small Signal Transistors

TYPE NO.	POLARITY	CASE	MAXIMUM RATINGS Pd (mW)	Ic (mA)	VCEO (V)	HFE min	max	Ic (mA)	VCE (V)	VCE(SAT) max (V)	Ic (mA)	fT min (MHz)	Cob max (pF)	N.F. max (dB)
2N 4286	N	TO-92B	250	100	25	150	600	1	5	0.35	1	40	6	–
2N 4287	N	TO-92B	250	100	45	150	600	1	5	0.35	1	40	6	5
2N 4288	P	TO-92B	250	100	25	150	600	1	5	0.35	1	40	8	–
2N 4289	P	TO-92B	250	100	45	150	600	1	5	0.35	1	40	8	4
2N 4290	P	TO-92B	250	600	20	50	300	100	10	0.4	100	100	10	–
2N 4291	P	TO-92B	250	600	30	100	300	100	10	0.4	100	100	10	–
2N 4359	P	TO-18	360	50	45	50	600	1	5	–	–	20	6	4
2N 4384	N	TO-18	300	50	30	100	500	0.01	5	0.2	10	30	8	2
2N 4386	N	TO-18	300	50	30	40	500	0.01	5	0.2	10	30	8	3
2N 4964	P	TO-106	200	100	40	30	120	0.01	5	0.4	10	60	8	6
2N 4965	P	TO-106	200	100	40	80	400	0.01	5	0.4	10	60	8	6
2N 4966	N	TO-106	200	100	40	40	200	0.01	5	0.4	10	40	6	6
2N 4967	N	TO-106	200	100	40	100	600	0.01	5	0.4	10	40	6	6
2N 4968	N	TO-106	200	100	25	40	200	0.01	5	0.4	10	40	6	6
2N 5086	P	TO-92A	350	50	50	150	500	0.1	5	0.3	10	40	4	3
2N 5088	N	TO-92A	350	50	30	300	900	0.1	5	0.5	10	50	4	3
2N 5089	N	TO-92A	350	50	25	400	1200	0.1	5	0.5	10	50	4	2
2N 5133	N	TO-106	200	50	18	60	1000	1	5	0.4	10	40	5	–
2N 5138	P	TO-106	200	50	30	50	800	0.1	10	0.3	10	30	7	–
2N 5172	N	TO-92B	200	100	25	100	500	10	10	0.25	10	–	–	–
2N 5209	N	TO-92A	350	50	50	100	300	0.1	5	0.7	10	30	4	4
2N 5219	N	TO-92A	350	100	15	35	500	2	10	0.4	10	150	4	–
2N 5223	N	TO-92A	350	100	20	50	800	2	10	0.7	10	150	4	–
2N 5227	P	TO-92A	350	50	30	50	700	2	10	0.4	10	100	5	–
2N 5309	N	TO-92B	360	100	50	60	120	0.01	5	0.125	10	–	4	–
2N 5310	N	TO-92B	360	100	50	100	300	0.01	5	0.125	10	–	4	–
2N 5824	N	TO-92F	360	100	40	60	120	2	5	0.125	10	90	4	–
2N 5825	N	TO-92F	360	100	40	100	200	2	5	0.125	10	90	4	–
2N 5826	N	TO-92F	360	100	40	150	300	2	5	0.125	10	90	4	–
2N 5827	N	TO-92F	360	100	40	250	500	2	5	0.125	10	90	4	–
2N 5828	N	TO-92F	360	100	40	400	800	2	5	0.125	10	90	4	–
2SA 499	P	TO-18	250	100	20	60	200#	10	1	0.4	0.01	100	7	–
2SA 500	P	TO-18	250	100	20	60	200#	10	1	0.4	0.01	100	7	–
2SA 550	P	TO-18	300	50	25	65	700#	2	5	–	–	120+	5+	–
2SA 550A	P	TO-18	300	50	45	65	700#	2	5	–	–	120+	5+	–
2SA 564	P	TO-92B	250	50	25	65	700#	2	5	0.4	50	150+	3.2+	2+
2SA 564A	P	TO-92B	250	50	45	65	700#	2	5	0.4	50	150+	3.2+	2+
2SA 666	P	TO-92B	250	50	25	130	700#	2	5	0.4	50	80+	–	16
2SA 666A	P	TO-92B	250	50	45	130	700#	2	5	0.4	50	80+	–	16
2SA 721	P	TO-92B	150	50	35	180	1040#	2	5	0.6	100	250+	–	–
2SA 722	P	TO-92B	150	50	55	180	1040#	2	5	0.6	100	250+	–	–
2SA 888	P	TO-92A	350	50	25	65	700#	2	5	0.5	50	100+	2.7+	–
2SA 889	P	TO-92A	350	50	45	65	700#	2	5	0.5	50	100+	2.7+	–
2SC 316	N	TO-18	300	50	45	–	600	2	5	1.2	10	50+	–	–
2SC 400	N	TO-18	250	100	20	30	350#	10	1	0.4	0.01	100	6	–
2SC 536	N	TO-92B	200	100	20	40	850#	1	6	–	–	–	6	–
2SC 537	N	TO-92B	200	100	–	40	850#	1	6	–	–	–	6	–
2SC 538	N	TO-18	300	50	25	90	700#	2	5	0.32	100	180+	4+	–
2SC 538A	N	TO-18	300	50	45	90	700#	2	5	0.32	100	180+	4+	–
2SC 539	N	TO-18	300	50	25	90	700#	2	5	0.32	100	180+	4+	4
2SC 644	N	TO-92B	150	50	25	130	700#	2	5	0.4	50	75	10	3
2SC 693	N	TO-92B	100	50	–	100	850#	1	6	–	–	90	6	–
2SC 828	N	TO-92B	250	50	25	65	700#	2	5	0.4	50	150+	2.5+	2+
2SC 828A	N	TO-92B	250	50	45	65	700#	2	5	0.4	50	150+	2.5+	2+

#HFE groupings available + Typical value

Audio Frequency Small Signal Transistors

TYPE NO.	POLARITY	CASE	MAXIMUM RATINGS			HFE				VCE(SAT)		fT	Cob	N.F.
			Pd (mW)	IC (mA)	VCEO (V)	min	max	IC (mA)	VCE (V)	max (V)	IC (mA)	min (MHz)	max (pF)	max (dB)
2SC 858	N	TO-92B	100	50	12	100	850#	1	6	–	–	90	6	–
2SC 900	N	TO-92B	250	100	35	225	1000#	0.5	3	0.3	100	50	5	4
2SC 923	N	TO-92B	250	100	35	225	1000#	0.5	3	0.3	100	50	5	20
2SC 945	N	TO-92B	250	100	50	90	600#	1	6	0.3	100	150	5	15
2SC 1327	N	TO-92B	150	50	35	180	1040#	2	5	0.6	100	250+	–	–
2SC 1330	N	TO-92B*	400	100	40	60	400#	1	6	0.5	30	50	6	–
2SC 1684	N	TO-92B	250	100	25	90	650#	2	10	0.5	100	150+	3.5+	–
2SC 1685	N	TO-92B	250	100	50	90	650#	2	10	0.5	100	150+	3.5+	–
2SC 1849	N	TO-92A	350	100	25	90	650#	2	10	0.5	100	–	–	–
2SC 1850	N	TO-92A	350	100	50	90	650#	2	10	0.5	100	–	–	–

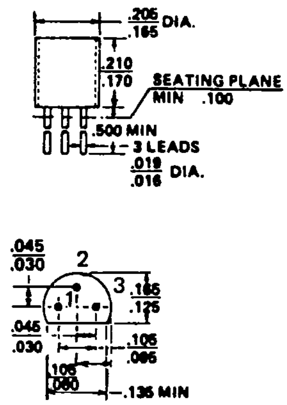
HFE groupings available   + Typical value   * with x-67 heatsink

Packaging Information

PACKAGING INFORMATION

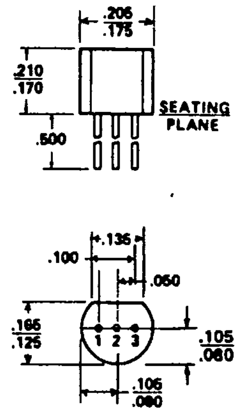
TO-18 (PLASTIC)

1. CATHODE
2. GATE
3. ANODE



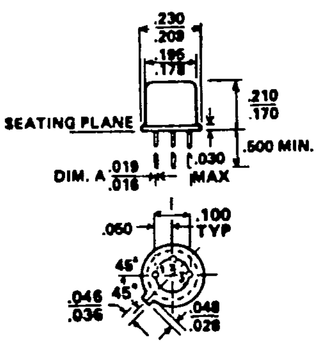
TO-92

SCR	TRIAC
1. CATHODE	1. MT 1
2. GATE	2. GATE
3. ANODE	3. MT 2



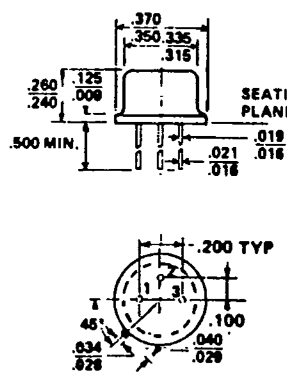
TO-18

1. CATHODE
2. GATE
3. ANODE

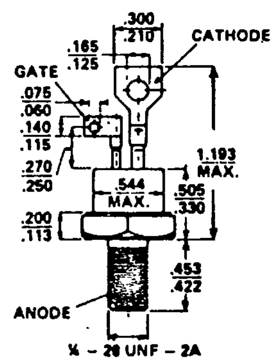


TO-39

SCR	TRIAC
1. CATHODE	1. MT 1
2. GATE	2. GATE
3. ANODE	3. MT 2



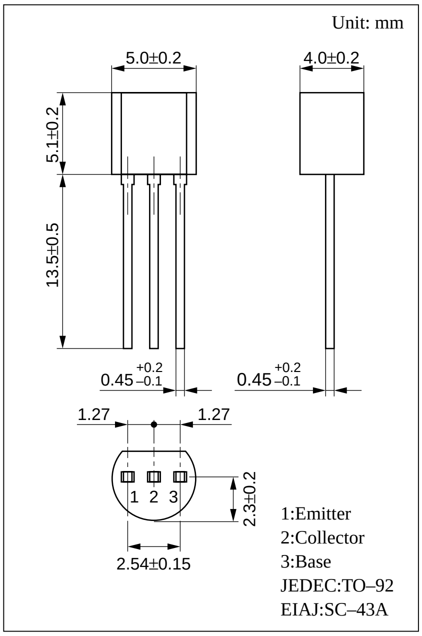
TO-48D



2SC829

Silicon NPN epitaxial planer type

For high-frequency amplification



■ Features

- Optimum for RF amplification, oscillation, mixing, and IF stage of FM/AM radios.

■ Absolute Maximum Ratings (Ta=25˚C)

Parameter	Symbol	Ratings	Unit
Collector to base voltage	V_{CBO}	30	V
Collector to emitter voltage	V_{CEO}	20	V
Emitter to base voltage	V_{EBO}	5	V
Collector current	I_C	30	mA
Collector power dissipation	P_C	400	mW
Junction temperature	T_j	150	˚C
Storage temperature	T_{stg}	–55 ~ +150	˚C

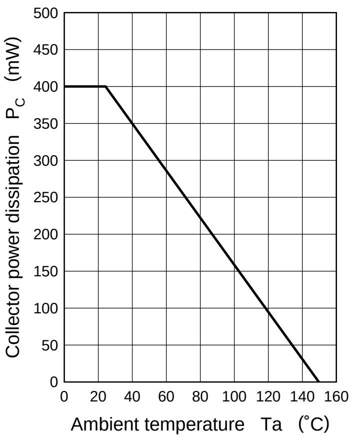
■ Electrical Characteristics (Ta=25˚C)

Parameter	Symbol	Conditions	min	typ	max	Unit
Collector to base voltage	V_{CBO}	I_C = 10μA, I_E = 0	30			V
Collector to emitter voltage	V_{CEO}	I_C = 2mA, I_B = 0	20			V
Emitter to base voltage	V_{EBO}	I_E = 10μA, I_C = 0	5			V
Forward current transfer ratio	h_{FE}*	V_{CE} = 10V, I_C = 1mA	70		250	
Transition frequency	f_T	V_{CB} = 10V, I_C = 1mA, f = 200MHz	150	230		MHz
Common emitter reverse transfer capacitance	C_{re}	V_{CE} = 10V, I_C = 1mA, f = 10.7MHz		1.3	1.6	pF
Reverse transfer impedance	Z_{rb}	V_{CB} = 10V, I_E = –1mA, f = 2MHz			60	Ω

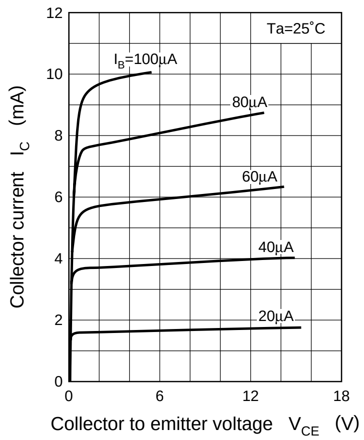
*h_{FE} Rank classification

Rank	B	C
h_{FE}	70 ~ 160	110 ~ 250

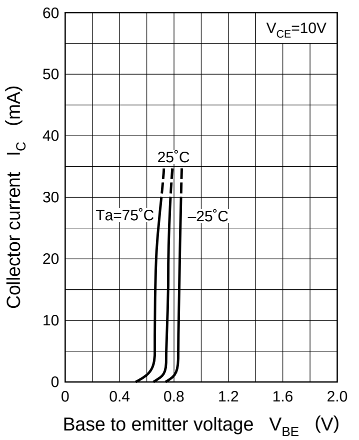
P_C — Ta



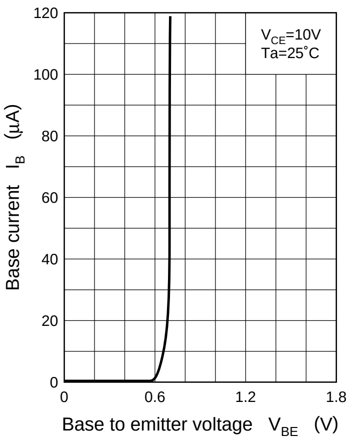
I_C — V_{CE}



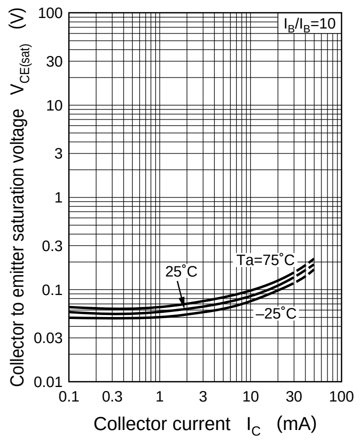
I_C — V_{BE}



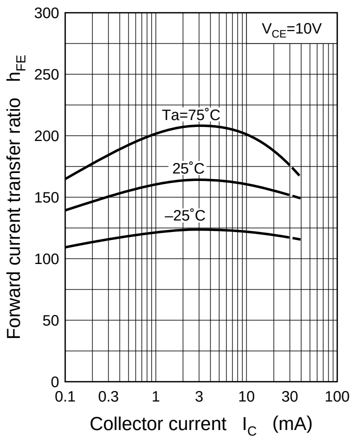
I_B — V_{BE}



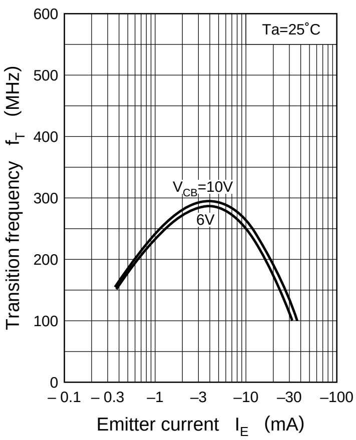
$V_{CE(sat)}$ — I_C



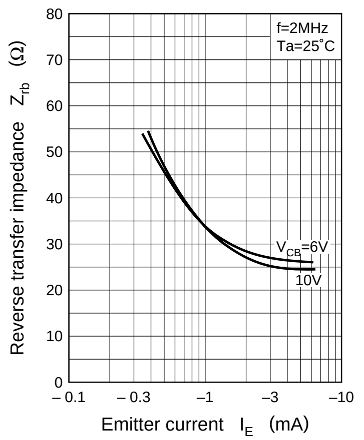
h_{FE} — I_C



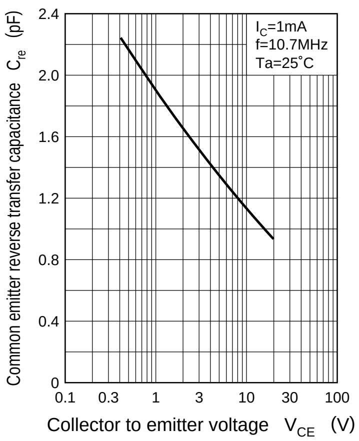
f_T — I_E



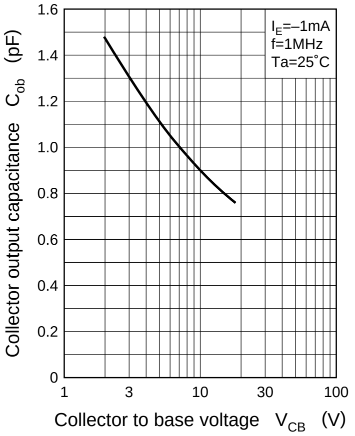
Z_{rb} — I_E



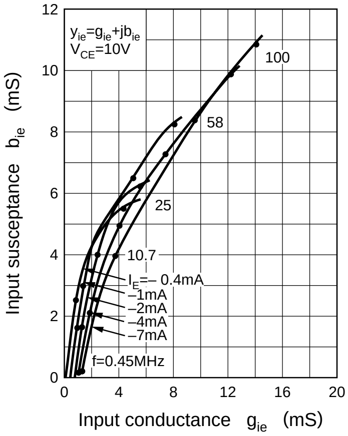
C_{re} — V_{CE}



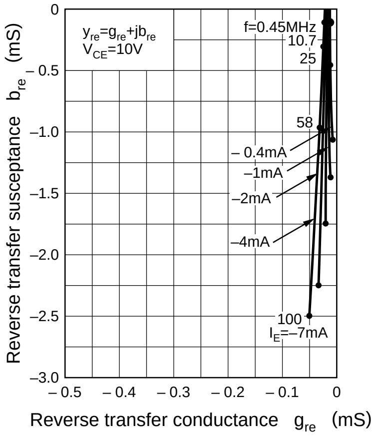
C_{ob} — V_{CB}



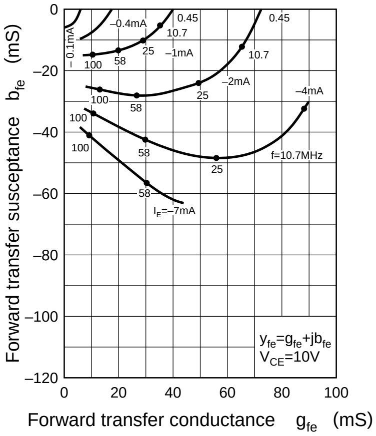
b_{ie} — g_{ie}



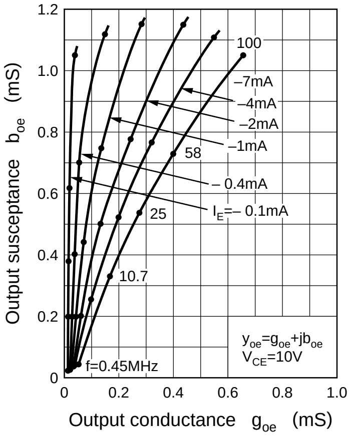
b_{re} — g_{re}



b_{fe} — g_{fe}



b_{oe} — g_{oe}



2SC1162

Silicon NPN Epitaxial

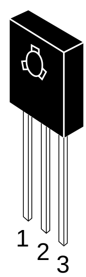
HITACHI

Application

Low frequency power amplifier complementary pair with 2SA715

Outline

TO-126 MOD



1. Emitter
2. Collector
3. Base

Absolute Maximum Ratings (Ta = 25°C)

Item	Symbol	Ratings	Unit
Collector to base voltage	V_{CBO}	35	V
Collector to emitter voltage	V_{CEO}	35	V
Emitter to base voltage	V_{EBO}	5	V
Collector current	I_C	2.5	A
Collector peak current	$I_{C(peak)}$	3	A
Collector power dissipation	P_C	0.75	W
	P_C*[1]	10	W
Junction temperature	Tj	150	°C
Storage temperature	Tstg	–55 to +150	°C

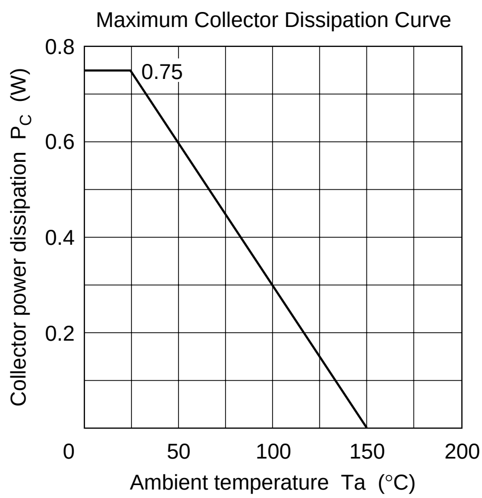
Note: 1. Value at T_C = 25°C.

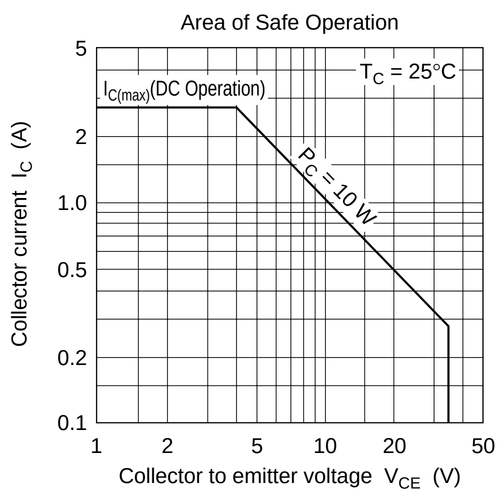
Electrical Characteristics (Ta = 25°C)

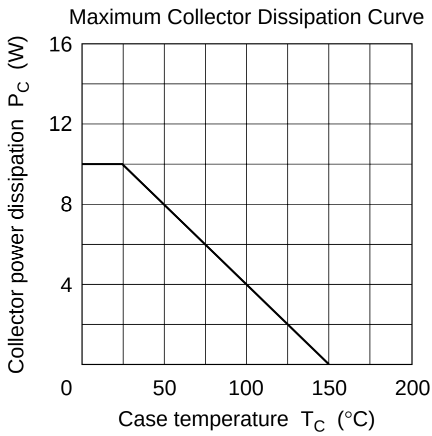
Item	Symbol	Min	Typ	Max	Unit	Test conditions
Collector to base breakdown voltage	$V_{(BR)CBO}$	35	—	—	V	I_C = 1 mA, I_E = 0
Collector to emitter breakdown voltage	$V_{(BR)CEO}$	35	—	—	V	I_C = 10 mA, R_{BE} = ∞
Emitter to base breakdown voltage	$V_{(BR)EBO}$	5	—	—	V	I_E = 1 mA, I_C = 0
Collector cutoff current	I_{CBO}	—	—	20	µA	V_{CB} = 35 V, I_E = 0
DC current transfer ratio	h_{FE}*1	60	—	320		V_{CE} = 2 V, I_C = 0.5 A
	h_{FE}	20	—	—		V_{CE} = 2 V, I_C = 1.5 A (pulse test)
Base to emitter voltage	V_{BE}	—	0.93	1.5	V	V_{CE} = 2 V, I_C = 1.5 A (pulse test)
Collector to emitter saturation voltage	$V_{CE(sat)}$	—	0.5	1.0	V	I_C = 2 A, I_B = 0.2 A (pulse test)
Gain bandwidth product	f_T	—	180	—	MHz	V_{CE} = 2 V, I_C = 0.2 A

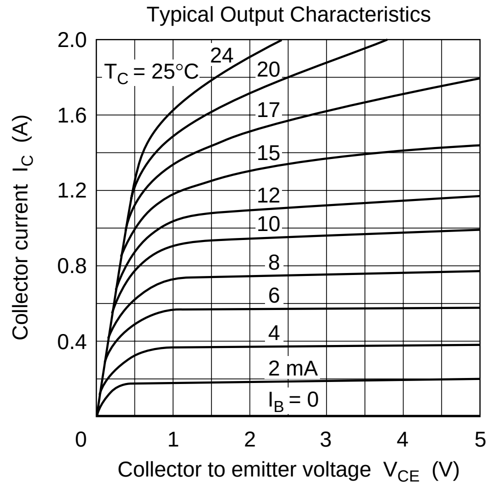
Note: 1. The 2SC1162 is grouped by h_{FE} as follows.

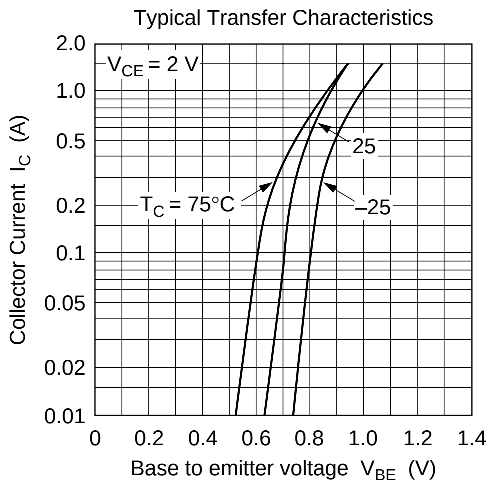
B	C	D
60 to 120	100 to 200	160 to 320

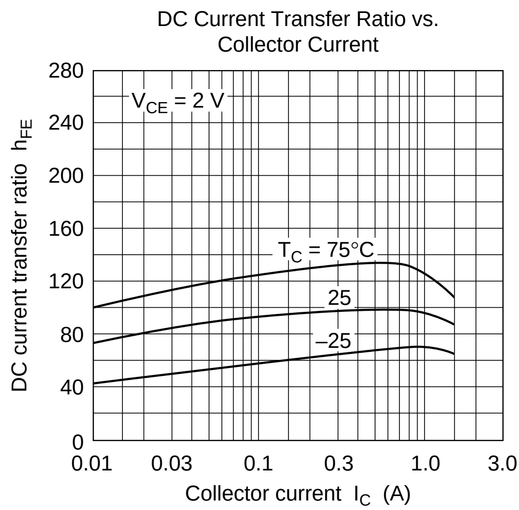




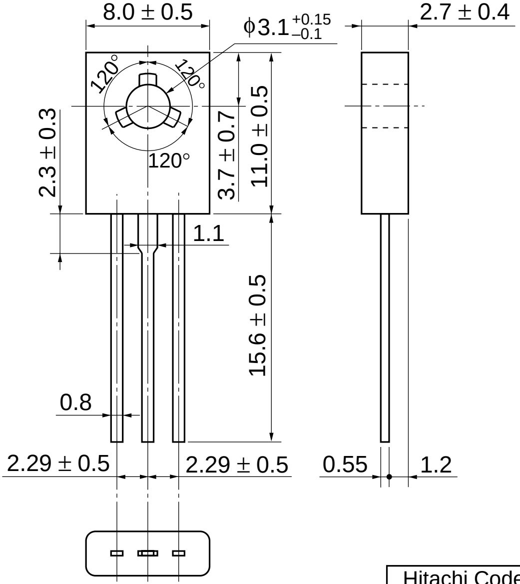

Maximum Collector Dissipation Curve
Collector power dissipation P_C (W)
16
12
8
4
0
50
100
150
200
Case temperature T_C (°C)

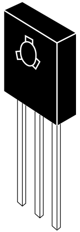

Typical Output Characteristics
T_C = 25°C
24
20
17
15
12
10
8
6
4
2 mA
I_B = 0
Collector current I_C (A)
2.0
1.6
1.2
0.8
0.4
0
1
2
3
4
5
Collector to emitter voltage V_{CE} (V)


Typical Transfer Characteristics
V_{CE} = 2 V
T_C = 75°C
25
–25
Collector Current I_C (A)
2.0
1.0
0.5
0.2
0.1
0.05
0.02
0.01
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Base to emitter voltage V_{BE} (V)


DC Current Transfer Ratio vs.
Collector Current
V_{CE} = 2 V
T_C = 75°C
25
–25
DC current transfer ratio h_{FE}
280
240
200
160
120
80
40
0
0.01
0.03
0.1
0.3
1.0
3.0
Collector current I_C (A)

Unit: mm





Hitachi Code	TO-126 Mod
JEDEC	—
EIAJ	—
Weight (reference value)	0.67 g

Cautions

1. Hitachi neither warrants nor grants licenses of any rights of Hitachi’s or any third party’s patent, copyright, trademark, or other intellectual property rights for information contained in this document. Hitachi bears no responsibility for problems that may arise with third party’s rights, including intellectual property rights, in connection with use of the information contained in this document.
2. Products and product specifications may be subject to change without notice. Confirm that you have received the latest product standards or specifications before final design, purchase or use.
3. Hitachi makes every attempt to ensure that its products are of high quality and reliability. However, contact Hitachi’s sales office before using the product in an application that demands especially high quality and reliability or where its failure or malfunction may directly threaten human life or cause risk of bodily injury, such as aerospace, aeronautics, nuclear power, combustion control, transportation, traffic, safety equipment or medical equipment for life support.
4. Design your application so that the product is used within the ranges guaranteed by Hitachi particularly for maximum rating, operating supply voltage range, heat radiation characteristics, installation conditions and other characteristics. Hitachi bears no responsibility for failure or damage when used beyond the guaranteed ranges. Even within the guaranteed ranges, consider normally foreseeable failure rates or failure modes in semiconductor devices and employ systemic measures such as fail-safes, so that the equipment incorporating Hitachi product does not cause bodily injury, fire or other consequential damage due to operation of the Hitachi product.
5. This product is not designed to be radiation resistant.
6. No one is permitted to reproduce or duplicate, in any form, the whole or part of this document without written approval from Hitachi.
7. Contact Hitachi’s sales office for any questions regarding this document or Hitachi semiconductor products.

HITACHI

Hitachi, Ltd.
Semiconductor & Integrated Circuits.
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan
Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

URL		
	NorthAmerica	: http:semiconductor.hitachi.com/
	Europe	: http://www.hitachi-eu.com/hel/ecg
	Asia (Singapore)	: http://www.has.hitachi.com.sg/grp3/sicd/index.htm
	Asia (Taiwan)	: http://www.hitachi.com.tw/E/Product/SICD_Frame.htm
	Asia (HongKong)	: http://www.hitachi.com.hk/eng/bo/grp3/index.htm
	Japan	: http://www.hitachi.co.jp/Sicd/indx.htm

For further information write to:

Hitachi Semiconductor
(America) Inc.
179 East Tasman Drive,
San Jose,CA 95134
Tel: <1> (408) 433-1990
Fax: <1>(408) 433-0223

Hitachi Europe GmbH
Electronic components Group
Dornacher Stra§e 3
D-85622 Feldkirchen, Munich
Germany
Tel: <49> (89) 9 9180-0
Fax: <49> (89) 9 29 30 00

Hitachi Europe Ltd.
Electronic Components Group.
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA, United Kingdom
Tel: <44> (1628) 585000
Fax: <44> (1628) 778322

Hitachi Asia Pte. Ltd.
16 Collyer Quay #20-00
Hitachi Tower
Singapore 049318
Tel: 535-2100
Fax: 535-1533

Hitachi Asia Ltd.
Taipei Branch Office
3F, Hung Kuo Building. No.167,
Tun-Hwa North Road, Taipei (105)
Tel: <886> (2) 2718-3666
Fax: <886> (2) 2718-8180

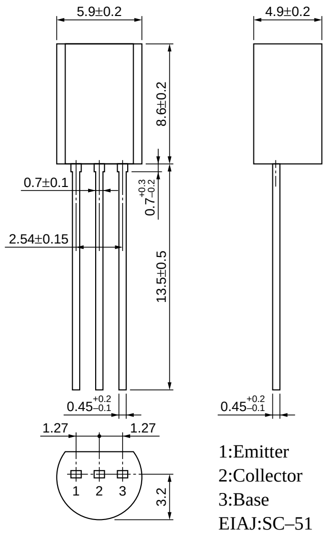
Hitachi Asia (Hong Kong) Ltd.
Group III (Electronic Components)
7/F., North Tower, World Finance Centre,
Harbour City, Canton Road, Tsim Sha Tsui,
Kowloon, Hong Kong
Tel: <852> (2) 735 9218
Fax: <852> (2) 730 0281
Telex: 40815 HITEC HX

2SC1383, 2SC1384

Silicon NPN epitaxial planer type

For low-frequency power amplification and driver amplification
Complementary to 2SA683 and 2SA684

Unit: mm



1:Emitter
2:Collector
3:Base
EIAJ:SC–51
TO–92L Package

■ Features

- Low collector to emitter saturation voltage $V_{CE(sat)}$.
- Complementary pair with 2SA683 and 2SA684.

■ Absolute Maximum Ratings (Ta=25˚C)

Parameter		Symbol	Ratings	Unit
Collector to base voltage	2SC1383	V_{CBO}	30	V
	2SC1384		60	
Collector to emitter voltage	2SC1383	V_{CEO}	25	V
	2SC1384		50	
Emitter to base voltage		V_{EBO}	5	V
Peak collector current		I_{CP}	1.5	A
Collector current		I_C	1	A
Collector power dissipation		P_C	1	W
Junction temperature		T_j	150	˚C
Storage temperature		T_{stg}	–55 ~ +150	˚C

■ Electrical Characteristics (Ta=25˚C)

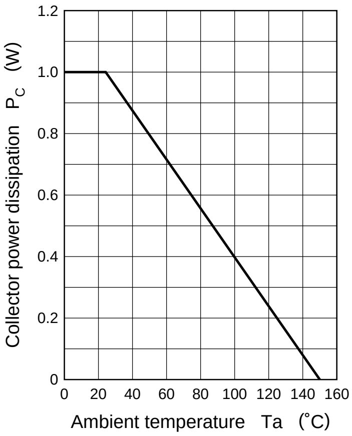
Parameter		Symbol	Conditions	min	typ	max	Unit
Collector cutoff current		I_{CBO}	V_{CB} = 20V, I_E = 0			0.1	μA
Collector to base voltage	2SC1383	V_{CBO}	I_C = 10μA, I_E = 0	30			V
	2SC1384			60			
Collector to emitter voltage	2SC1383	V_{CEO}	I_C = 2mA, I_B = 0	25			V
	2SC1384			50			
Emitter to base voltage		V_{EBO}	I_E = 10μA, I_C = 0	5			V
Forward current transfer ratio		h_{FE1}*1	V_{CE} = 10V, I_C = 500mA*2	85	160	340	
		h_{FE2}	V_{CE} = 5V, I_B = 1A*2	50	100		
Collector to emitter saturation voltage		$V_{CE(sat)}$	I_C = 500mA, I_B = 50mA*2		0.2	0.4	V
Base to emitter saturation voltage		$V_{BE(sat)}$	I_C = 500mA, I_B = 50mA*2		0.85	1.2	V
Transition frequency		f_T	V_{CB} = 10V, I_E = –50mA, f = 200MHz		200		MHz
Collector output capacitance		C_{ob}	V_{CB} = 10V, I_E = 0, f = 1MHz		11	20	pF

*2 Pulse measurement

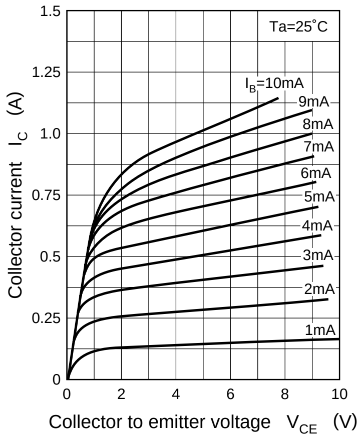
*1 h_{FE1} Rank classification

Rank	Q	R	S
h_{FE1}	85 ~ 170	120 ~ 240	170 ~ 340

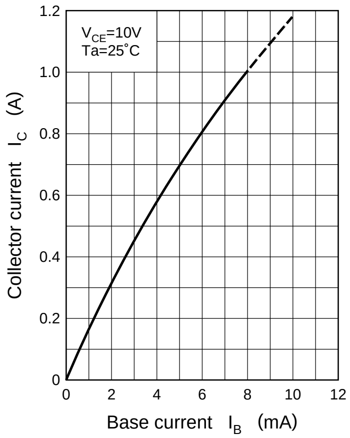
P_C — Ta



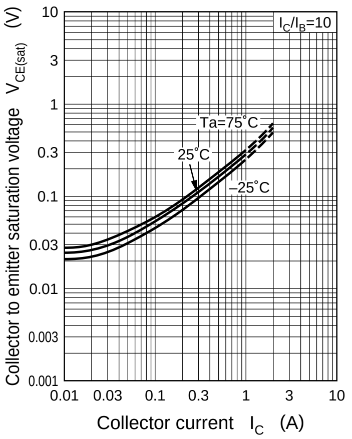
I_C — V_{CE}



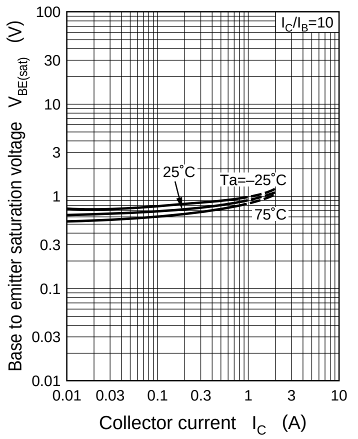
I_C — I_B



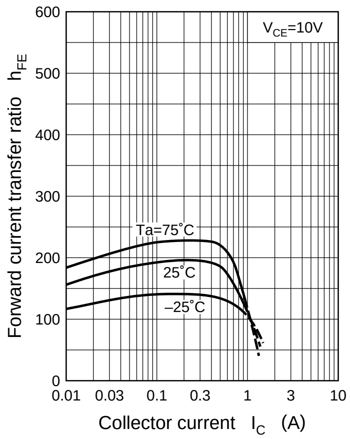
$V_{CE(sat)}$ — I_C



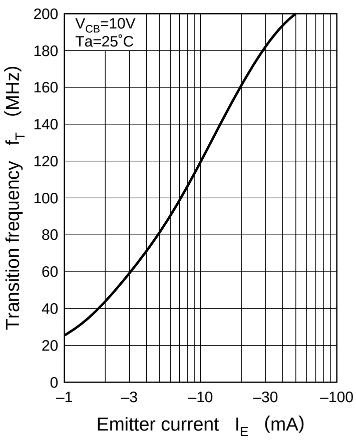
$V_{BE(sat)}$ — I_C



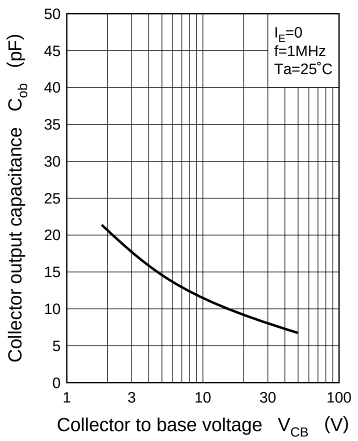
h_{FE} — I_C



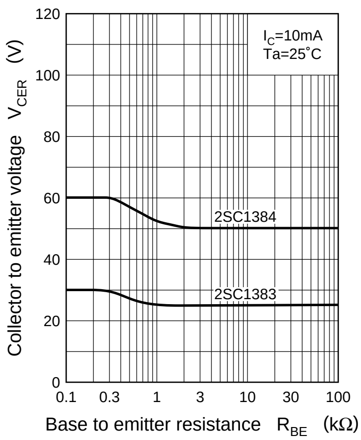
f_T — I_E



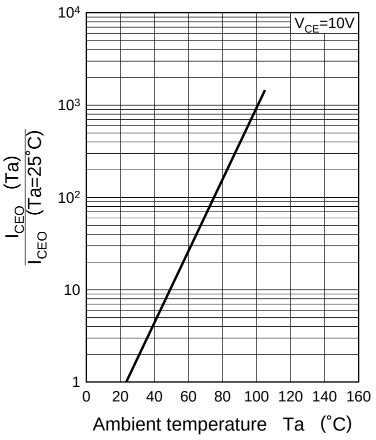
C_{ob} — V_{CB}



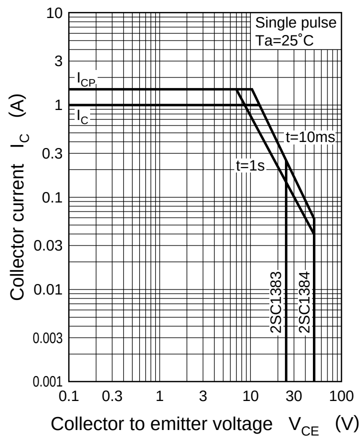
V_{CER} — R_{BE}



I_{CEO} — Ta



Area of safe operation (ASO)



2SC1969

NPN EPITAXIAL PLANAR TYPE

DESCRIPTION

2SC1969 is a silicon NPN epitaxial planar type transistor designed for RF power amplifiers on HF band mobile radio applications.

FEATURES

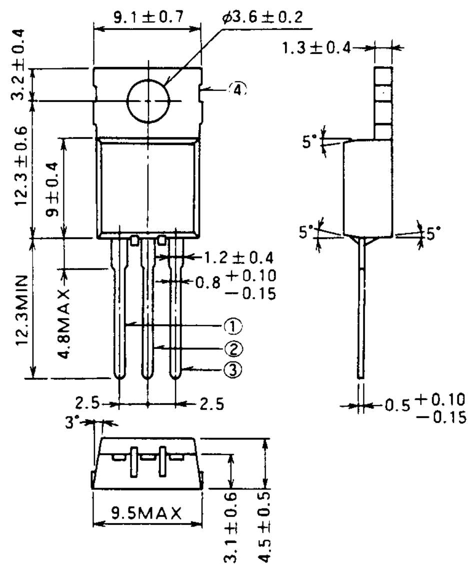
- High power gain: $G_{pe} \geq 12dB$ @V_{CC} = 12V, P_O = 16W, f = 27MHz
- Emitter ballasted construction for high reliaiblity and good performances.
- TO-220 package similarly is combinient for mounting.
- Ability of withstanding infinite load VSWR when operated at V_{CC} = 16V, P_O = 20W, f = 27MHz.

APPLICATION

10 to 14 watts output power class AB amplifiers applications in HF band.

OUTLINE DRAWING

Dimensions in mm



PIN :
① BASE
② COLLECTOR (FIN)
③ EMITTER
④ FIN (COLLECTOR)

T-30

ABSOLUTE MAXIMUM RATINGS (T_C = 25°C unless otherwise specified)

Symbol	Parameter	Conditions	Ratings	Unit
V_{CBO}	Collector to base voltage		60	V
V_{EBO}	Emitter to base voltage		5	V
V_{CEO}	Collector to emitter voltage	$R_{BE} = \infty$	25	V
I_C	Collector current		6	A
P_C	Collector dissipation	Ta = 25°C	1.7	W
		T_C = 25°C	20	W
T_j	Junction temperature		150	°C
T_{stg}	Storage temperature		−55 to 150	°C
R_{th-a}	Thermal resistance	Junction to ambient	73.5	°C/W
R_{th-c}		Junction to case	6.25	°C/W

Note. Above parameters are guaranteed independently.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise specified)

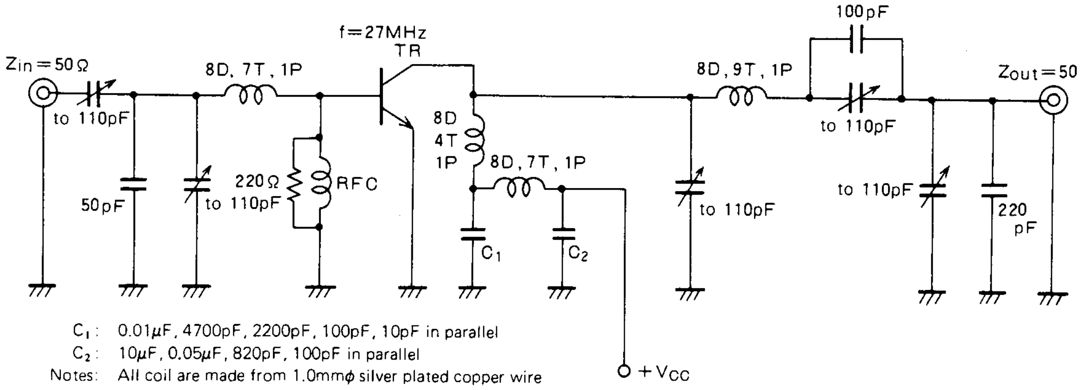
Symbol	Parameter	Test conditions	Limits Min	Limits Typ	Limits Max	Unit
$V_{(BR)EBO}$	Emitter to base breakdown voltage	I_E = 5mA, I_C = 0	5			V
$V_{(BR)CBO}$	Collector to base breakdown voltage	I_C = 1mA, I_E = 0	60			V
$V_{(BR)CEO}$	Collector to emitter breakdown voltage	I_C = 10mA, $R_{BE} = \infty$	25			V
I_{CBO}	Collector cutoff current	V_{CB} = 30V, I_E = 0			100	μA
I_{EBO}	Emitter cutoff current	V_{EB} = 4V, I_C = 0			100	μA
h_{FE}	DC forward current gain *	V_{CE} = 12V, I_C = 10mA	10	50	180	—
P_O	Output power	V_{CC} = 12V, P_{in} = 1w, f = 27MHz	16	18		W
η_C	Collector efficiency		60	70		%

Note. * Pulse test, P_W = 150μs, duty = 5%.
Above parameters, ratings, limits and conditions are subject to change.

Item	X	A	B	C	D
h_{FE}	10-25	20-45	35-70	55-110	90-180

NPN EPITAXIAL PLANAR TYPE

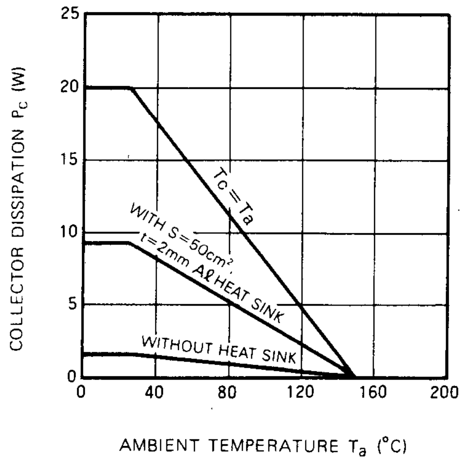
TEST CIRCUIT



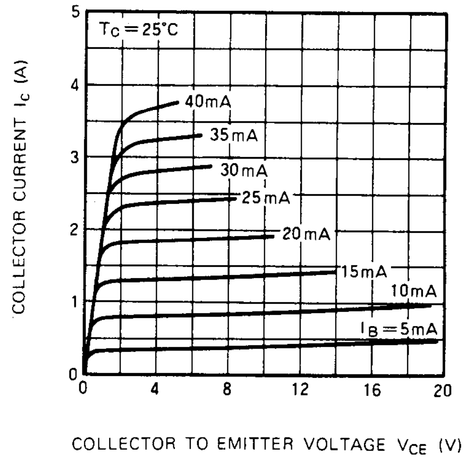
C_1: 0.01μF, 4700pF, 2200pF, 100pF, 10pF in parallel
C_2: 10μF, 0.05μF, 820pF, 100pF in parallel
Notes: All coil are made from 1.0mmφ silver plated copper wire
Coil dimensions in milli-meter
D: Inner diameter of coil
T: Turn number of coil
P: Pitch of coil

TYPICAL PERFORMANCE DATA

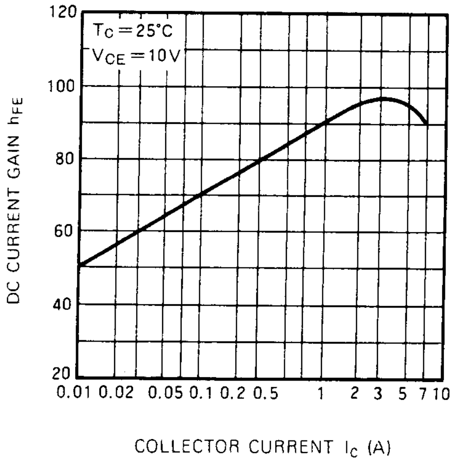
COLLECTOR DISSIPATION VS. AMBIENT TEMPERATURE



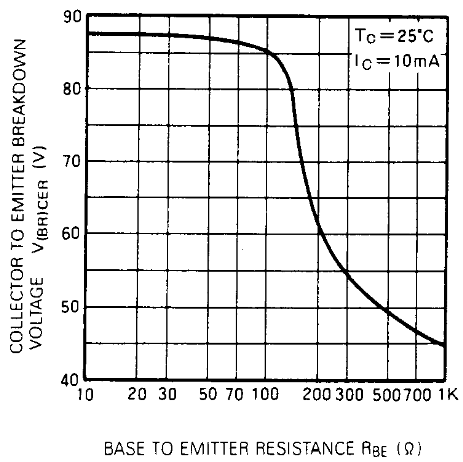
COLLECTOR CURRENT VS. COLLECTOR TO EMITTER VOLTAGE



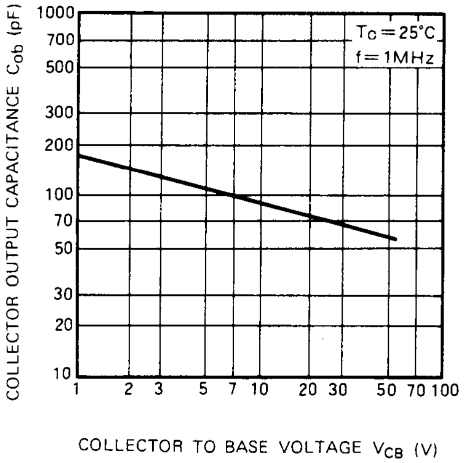
DC CURRENT GAIN VS. COLLECTOR CURRENT



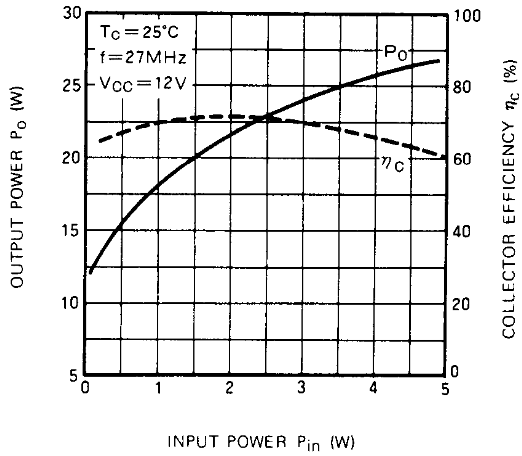
COLLECTOR TO EMITTER BREAKDOWN VOLTAGE VS. BASE TO EMITTER RESISTANCE



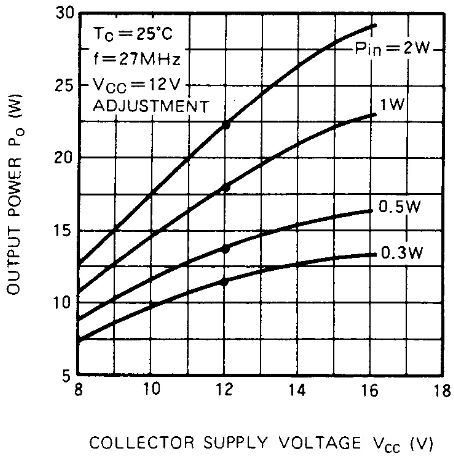
COLLECTOR OUTPUT CAPACITANCE VS. COLLECTOR TO BASE VOLTAGE CHARACTERISTICS



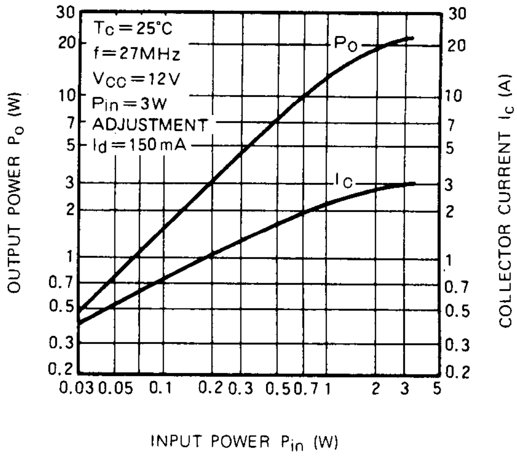
OUTPUT POWER, COLLECTOR EFFICIENCY VS. INPUT POWER



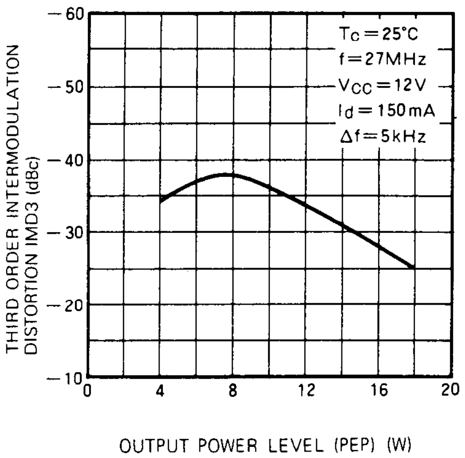
OUTPUT POWER VS. COLLECTOR SUPPLY VOLTAGE



IN CASE AB OPERATING OUTPUT POWER COLLECTOR CURRENT VS. INPUT POWER



THIRD ORDER INTERMODULATION DISTORTION VS. OUTPUT POWER



TOSHIBA FIELD EFFECT TRANSISTOR SILICON N CHANNEL JUNCTION TYPE

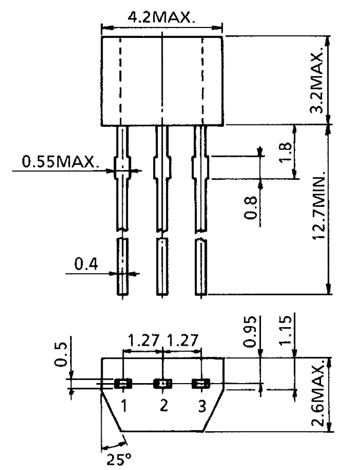
2SK192A

FM TUNER APPLICATIONS

VHF BAND AMPLIFIER APPLICATIONS

- High Power Gain : G_{PS} = 24dB (Typ.) (f = 100MHz)
- Low Noise Figure : NF = 1.8dB (Typ.) (f = 100MHz)
- High Forward Transfer Admittance
  : $|y_{fs}|$ = 7mS (Typ.) (f = 1kHz)

Unit in mm



1. DRAIN
2. SOURCE
3. GATE

JEDEC	—
EIAJ	—
TOSHIBA	2-4E1D

Weight : 0.13g

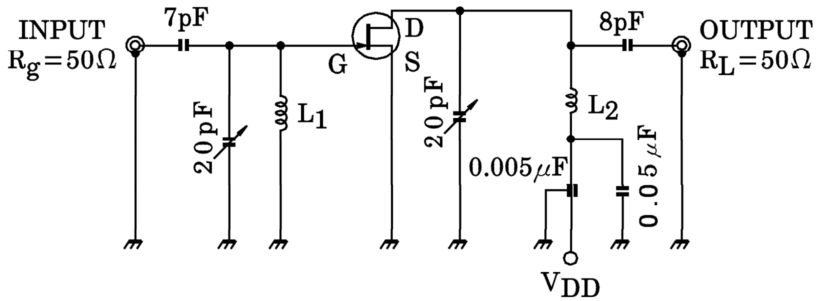
MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Gate-Drain Voltage	V_{GDO}	−18	V
Gate Current	I_G	10	mA
Drain Power Dissipation	P_D	200	mW
Junction Temperature	T_j	125	°C
Storage Temperature Range	T_{stg}	−55~125	°C

ELECTRICAL CHARACTERISTICS (Ta = 25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Gate Leakage Current	I_{GSS}	V_{GS} = −1.0V, V_{DS} = 0	—	—	−10	nA
Gate-Drain Breakdown Voltage	$V_{(BR)GDO}$	I_G = −100μA	−18	—	—	V
Drain Current	I_{DSS} (Note)	V_{GS} = 0, V_{DS} = 10V	3	—	24	mA
Gate-Source Cut-off Voltage	$V_{GS(OFF)}$	V_{DS} = 10V, I_D = 1μA	−1.2	−3	—	V
Forward Transfer Admittance	$\lvert y_{fs}\rvert$	V_{GS} = 0, V_{DS} = 10V, f = 1kHz	—	7	—	mS
Input Capacitance	C_{iss}	V_{DS} = 10V, V_{GS} = 0, f = 1MHz	—	3.5	—	pF
Reverse Transfer Capacitance	C_{rss}	V_{DS} = −10V, f = 1MHz	—	–	0.65	pF
Power Gain	G_{PS}	V_{DD} = 10V, f = 100MHz (Fig.1)	—	24	—	dB
Noise Figure	NF	V_{DD} = 10V, f = 100MHz (Fig.1)	—	1.8	3.5	dB

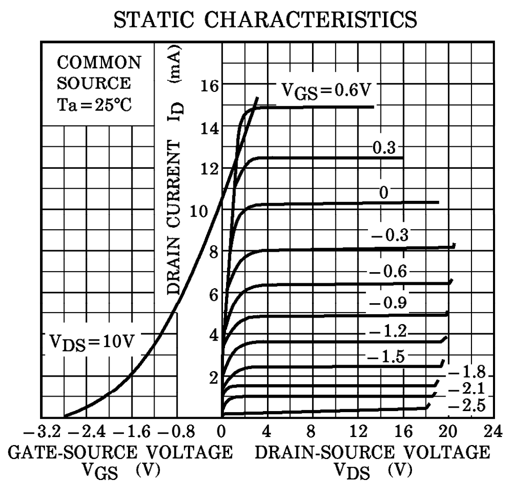
Note : I_{DSS} Classification Y : 3.0~7.0, GR : 6.0~14.0, BL : 12.0~24.0

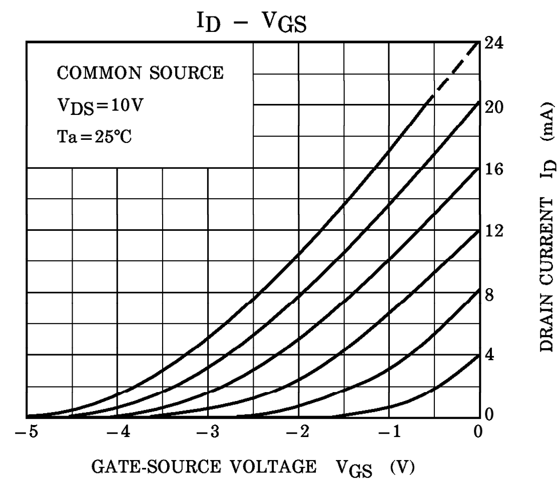


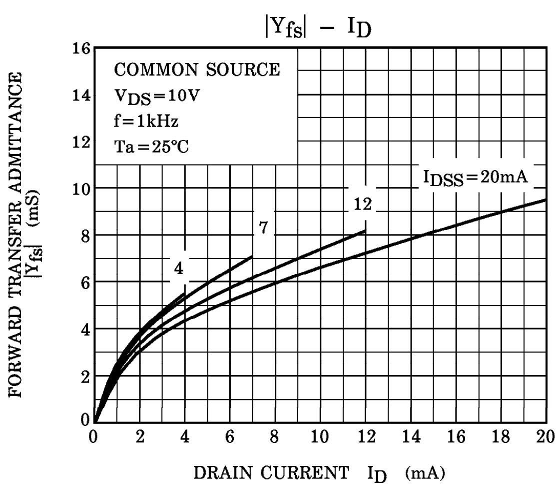
L_1 : 0.8mmϕ Ag PLATED Cu WIRE 3 TURNS, 10mm I_D, 10mm LENGTH

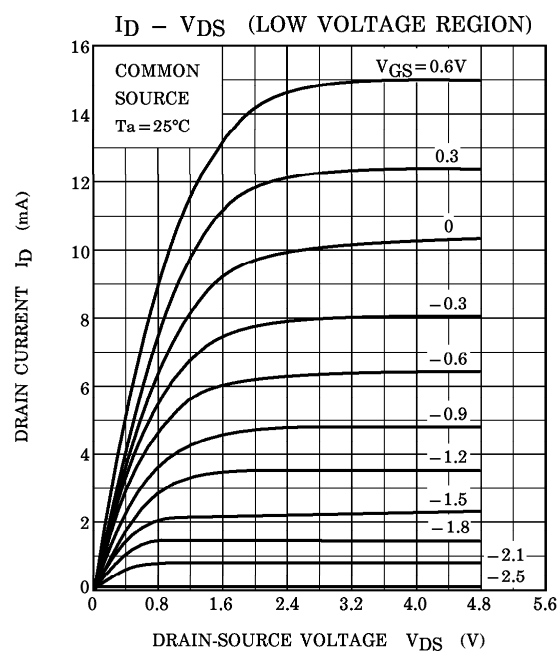
L_2 : 0.8mmϕ Ag PLATED Cu WIRE 3.5 TURNS, 10mm I_D, 10mm LENGTH

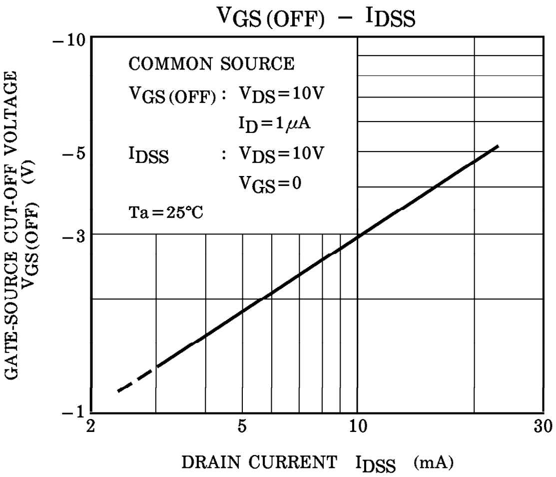
Fig.1 100MHz G_{ps}, NF TEST CIRCUIT

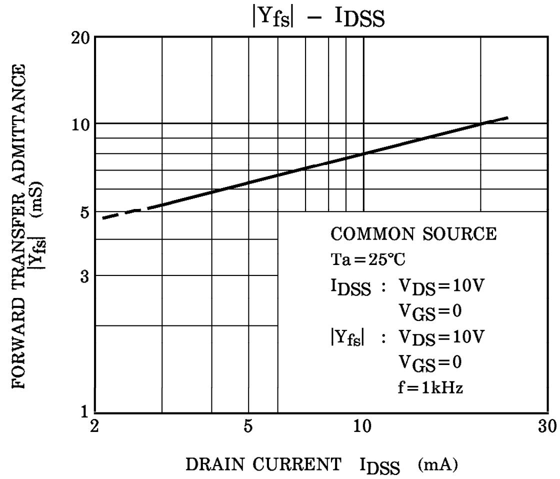


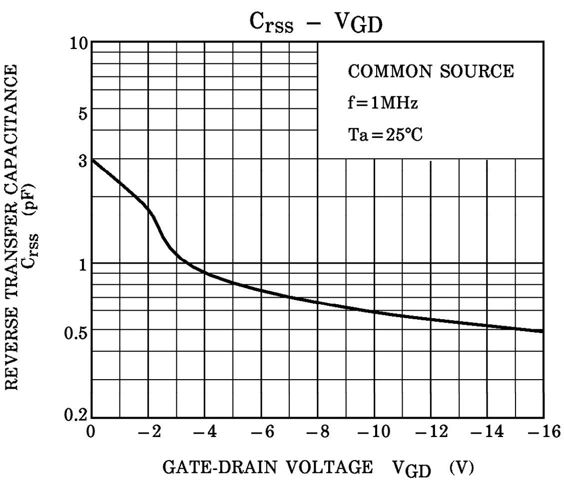


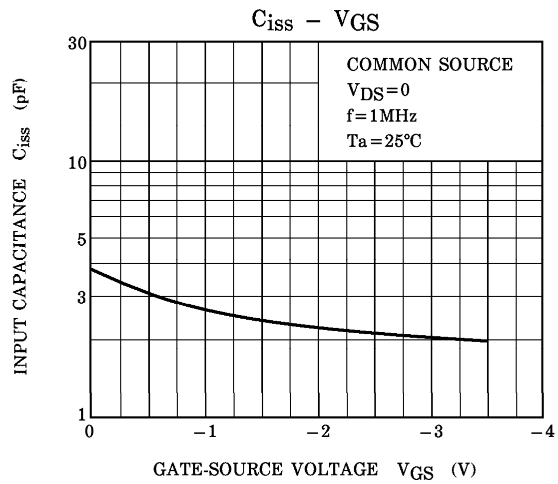


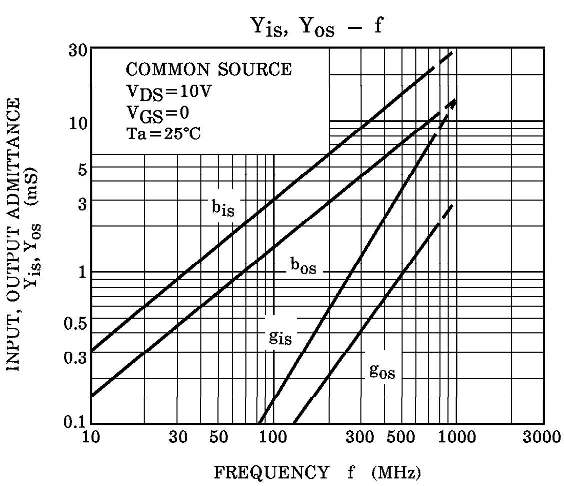


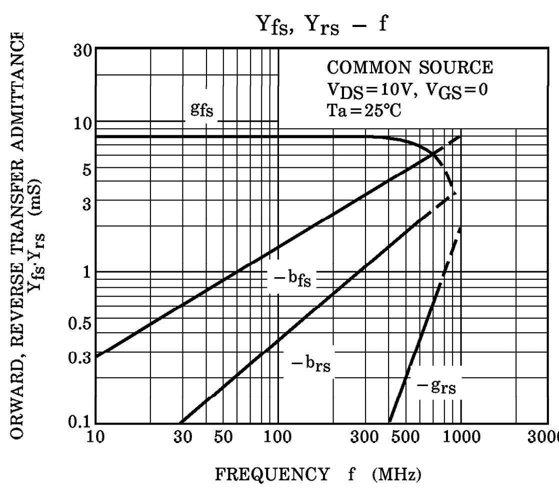

VGS (OFF) – IDSS
COMMON SOURCE
VGS (OFF) : VDS = 10V
ID = 1 μA
IDSS : VDS = 10V
VGS = 0
Ta = 25°C
GATE-SOURCE CUT-OFF VOLTAGE VGS (OFF) (V)
–10
–5
–3
–1
2
5
10
30
DRAIN CURRENT IDSS (mA)

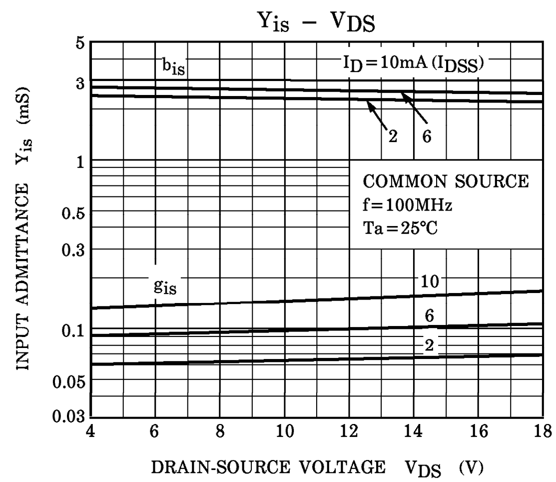

|Yfs| – IDSS
COMMON SOURCE
Ta = 25°C
IDSS : VDS = 10V
VGS = 0
|Yfs| : VDS = 10V
VGS = 0
f = 1kHz
FORWARD TRANSFER ADMITTANCE |Yfs| (mS)
20
10
5
3
1
2
5
10
30
DRAIN CURRENT IDSS (mA)

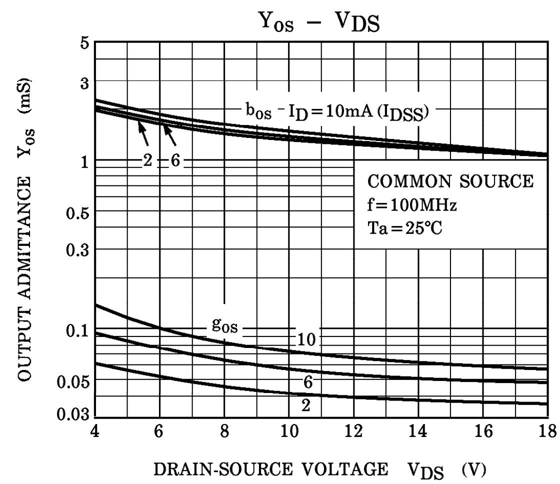

Crss – VGD
COMMON SOURCE
f = 1MHz
Ta = 25°C
REVERSE TRANSFER CAPACITANCE Crss (pF)
10
5
3
1
0.5
0.2
0
–2
–4
–6
–8
–10
–12
–14
–16
GATE-DRAIN VOLTAGE VGD (V)

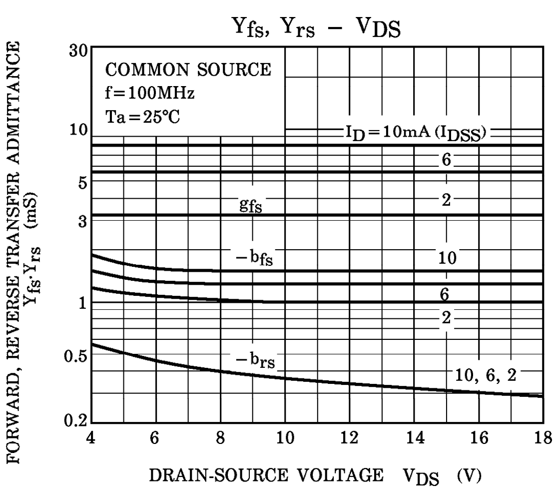

Ciss – VGS
COMMON SOURCE
VDS = 0
f = 1MHz
Ta = 25°C
INPUT CAPACITANCE Ciss (pF)
30
10
5
3
1
0
–1
–2
–3
–4
GATE-SOURCE VOLTAGE VGS (V)

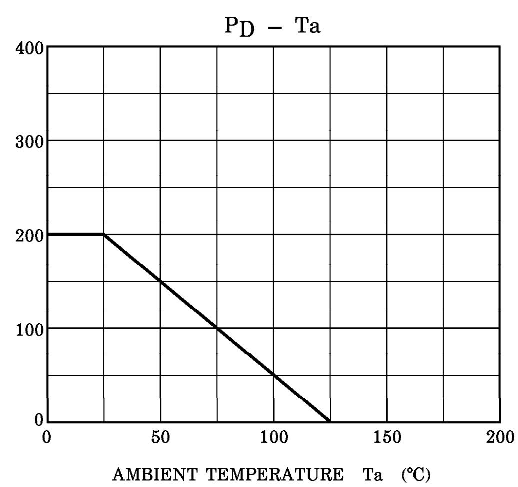

Yis, Yos – f
COMMON SOURCE
VDS = 10V
VGS = 0
Ta = 25°C
bis
bos
gis
gos
INPUT, OUTPUT ADMITTANCE Yis, Yos (mS)
30
10
5
3
1
0.5
0.3
0.1
10
30
50
100
300
500
1000
3000
FREQUENCY f (MHz)


Yfs, Yrs – f
COMMON SOURCE
VDS = 10V, VGS = 0
Ta = 25°C
gfs
–bfs
–brs
–grs
ORWARD, REVERSE TRANSFER ADMITTANCE Yfs, Yrs (mS)
30
10
5
3
1
0.5
0.3
0.1
10
30
50
100
300
500
1000
3000
FREQUENCY f (MHz)


Yis – VDS
INPUT ADMITTANCE Yis (mS)
bis
ID = 10mA (IDSS)
2
6
COMMON SOURCE
f = 100MHz
Ta = 25°C
gis
10
6
2
DRAIN-SOURCE VOLTAGE VDS (V)


Yos – VDS
OUTPUT ADMITTANCE Yos (mS)
bos ID = 10mA (IDSS)
2
6
COMMON SOURCE
f = 100MHz
Ta = 25°C
gos
10
6
2
DRAIN-SOURCE VOLTAGE VDS (V)


Yfs, Yrs – VDS
FORWARD, REVERSE TRANSFER ADMITTANCE Yfs·Yrs (mS)
COMMON SOURCE
f = 100MHz
Ta = 25°C
ID = 10mA (IDSS)
6
2
gfs
−bfs
10
6
2
−brs
10, 6, 2
DRAIN-SOURCE VOLTAGE VDS (V)


PD – Ta
AMBIENT TEMPERATURE Ta (°C)

Ordering number: EN4310

SANYO No.4310

2SK1921

N-Channel MOS Silicon FET

Very High-Speed Switching Applications

Features

- Low ON resistance.
- Very high-speed switching.
- Low-voltage drive.

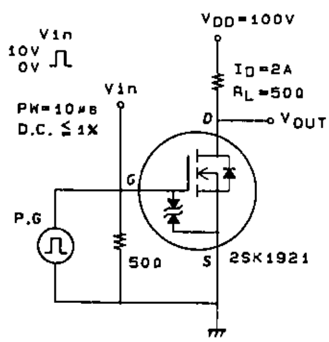
Absolute Maximum Ratings at Ta = 25°C

				unit
Drain-to-Source Voltage	V_{DSS}		250	V
Gate-to-Source Voltage	V_{GSS}		±30	V
Drain Current(DC)	I_D		4	A
Drain Current(Pulse)	I_{DP}	PW≦10μs, duty cycle≦1%	16	A
Allowable Power Dissipation	P_D		1.75	W
		T_c = 25°C	50	W
Channel Temperature	Tch		150	°C
Storage Temperature	Tstg		−55 to +150	°C

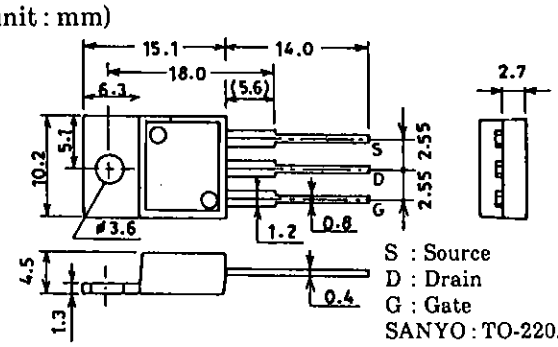
Electrical Characteristics at Ta = 25°C

			min	typ	max	unit
D-S Breakdown Voltage	$V_{(BR)DSS}$	I_D=1mA, V_{GS}=0	250			V
G-S Breakdown Voltage	$V_{(BR)GSS}$	I_G=±100μA, V_{DS}=0	±30			V
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS}=250V, V_{GS}=0			100	μA
Gate-to-Source Leakage Current	I_{GSS}	V_{GS}=±25V, V_{DS}=0			±10	μA
Cutoff Voltage	$V_{GS(off)}$	V_{DS}=10V, I_D=1mA	1.5		2.5	V
Forward Transfer Admittance	$\|y_{fs}\|$	V_{DS}=10V, I_D=2A	2.5	4		S
Static Drain-to-Source on State Resistance	$R_{DS(on)}$	I_D=2A, V_{GS}=10V		0.5	0.7	Ω
Input Capacitance	C_{iss}	V_{DS}=20V, f=1MHz		600		pF
Output Capacitance	C_{oss}	V_{DS}=20V, f=1MHz		100		pF
Reverse Transfer Capacitance	C_{rss}	V_{DS}=20V, f=1MHz		40		pF
Turn-ON Delay Time	$t_{d(on)}$	See specified Test Circuit.		12		ns
Rise Time	t_r	〃		15		ns
Turn-OFF Delay Time	$t_{d(off)}$	〃		65		ns
Fall Time	t_f	〃		55		ns
Diode Forward Voltage	V_{SD}	I_S=4A, V_{GS}=0		1.0	1.5	V

Switching Time Test Circuit



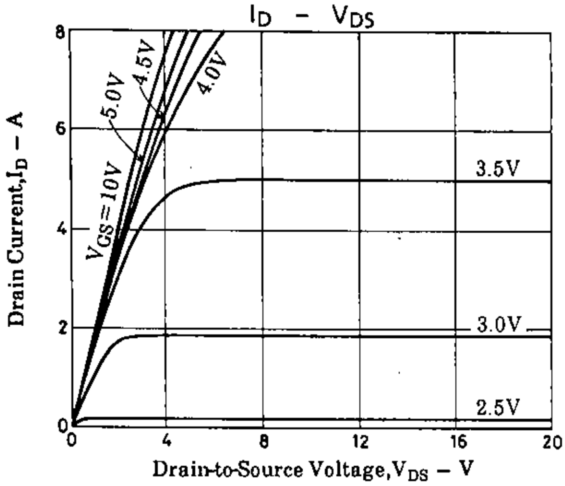
Package Dimensions 2052B
(unit : mm)



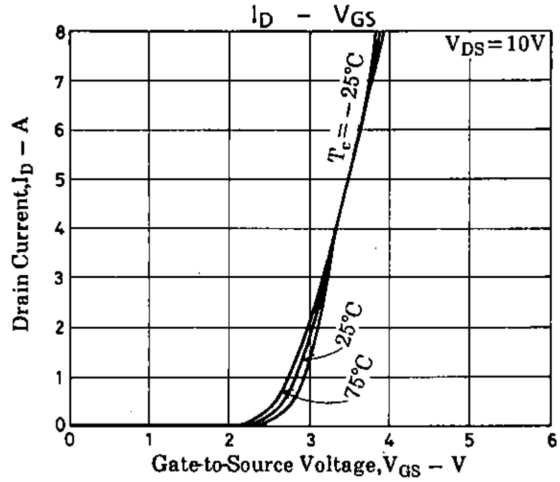
S : Source
D : Drain
G : Gate
SANYO : TO-220AB

SANYO Electric Co., Ltd. Semiconductor Business Headquarters
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110 JAPAN

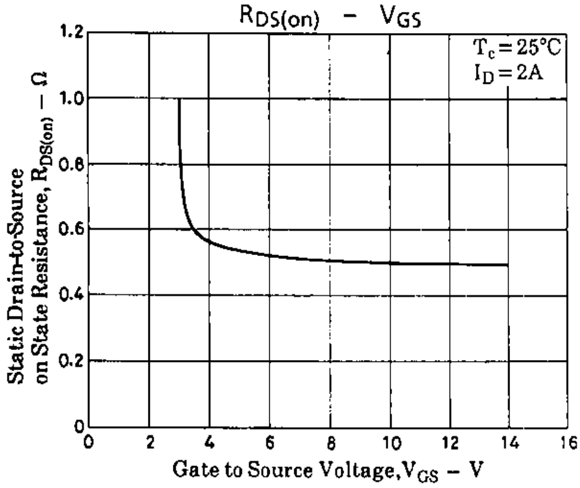
I_D – V_{DS}



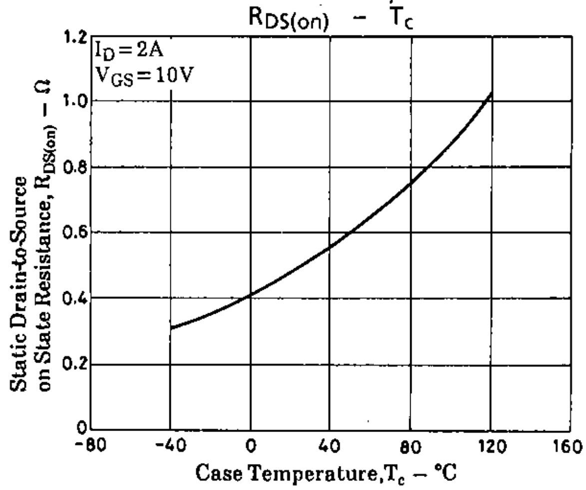
I_D – V_{GS}



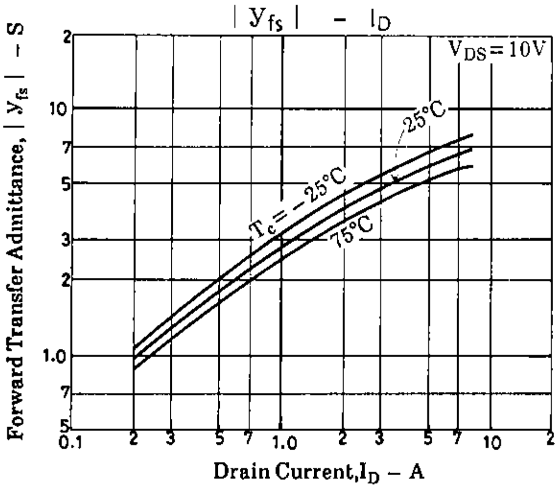
$R_{DS(on)}$ – V_{GS}



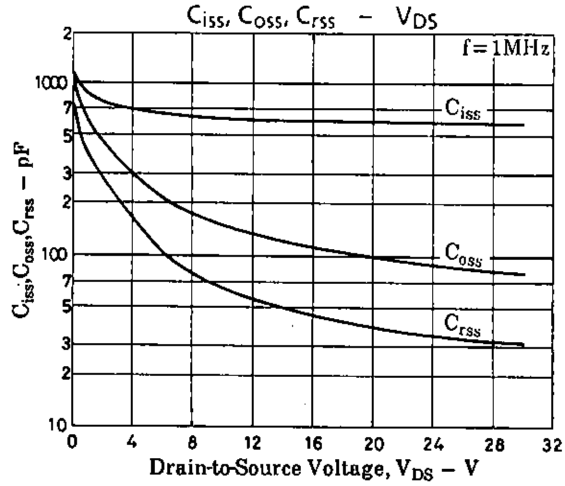
$R_{DS(on)}$ – T_c



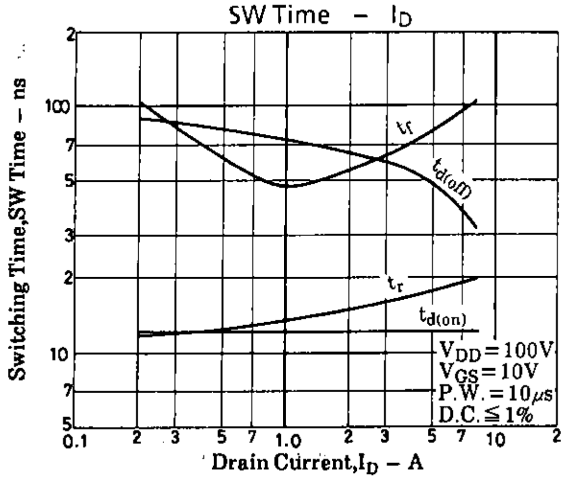
| y_{fs} | – I_D



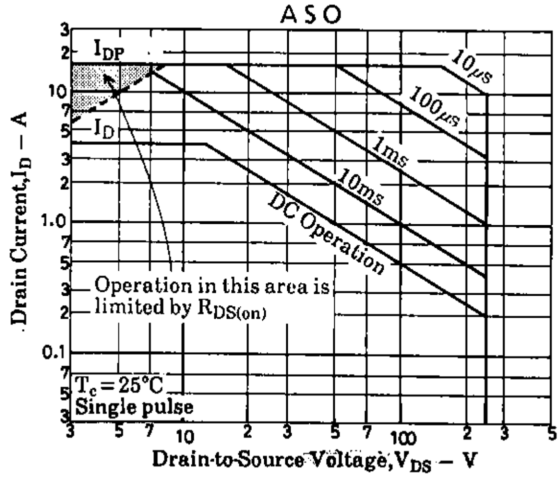
C_{iss}, C_{oss}, C_{rss} – V_{DS}

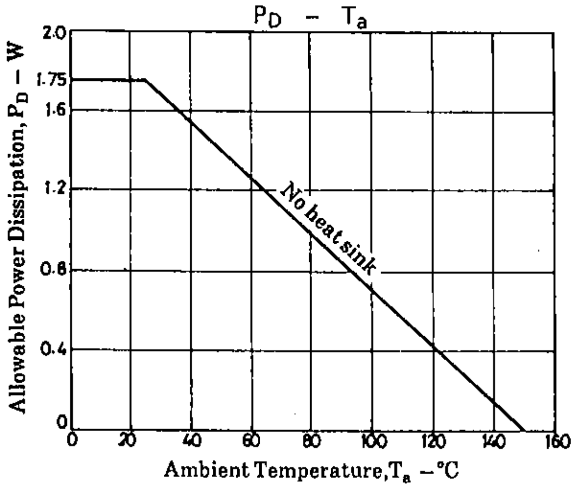


SW Time – I_D

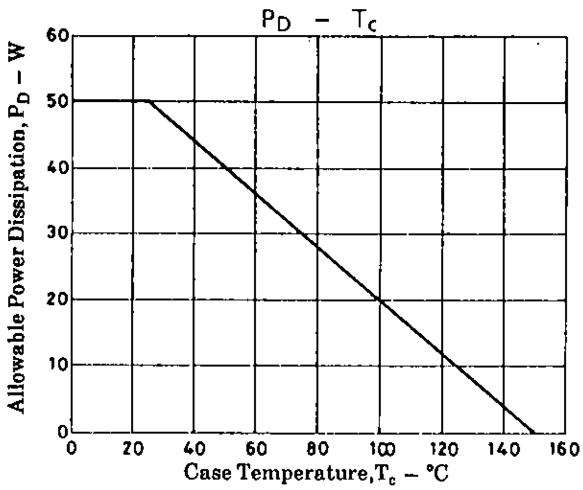


ASO





PD - Ta
Allowable Power Dissipation, PD - W
2.0
1.75
1.6
1.2
0.8
0.4
0
No heat sink
0
20
40
60
80
100
120
140
160
Ambient Temperature,Ta - °C



PD - Tc
Allowable Power Dissipation, PD - W
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
Case Temperature,Tc - °C

Ordering number: EN4312

No.4312

SANYO

2SK1923

N-Channel MOS Silicon FET

Very High-Speed Switching Applications

Features

- Low ON resistance.
- Very high-speed switching.
- High-speed diode (trr = 120ns).

Absolute Maximum Ratings at Ta = 25°C

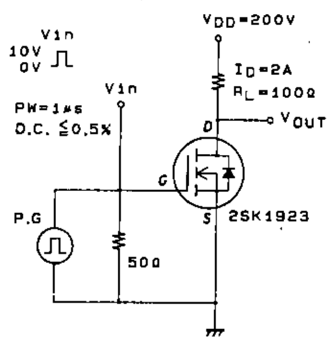
				unit
Drain-to-Source Voltage	V_{DSS}		600	V
Gate-to-Source Voltage	V_{GSS}		±30	V
Drain Current(DC)	I_D		4	A
Drain Current(Pulse)	I_{DP}		16	A
Allowable Power Dissipation	P_D		1.75	W
		$T_c = 25°C$	60	W
Channel Temperature	Tch		150	°C
Storage Temperature	Tstg		−55 to +150	°C

Electrical Characteristics at Ta = 25°C

			min	typ	max	unit
D-S Breakdown Voltage	V_{DSS}	$I_D = 10mA, V_{GS} = 0$	600			V
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 480V, V_{GS} = 0$			1.0	mA
Gate-to-Source Leakage Current	I_{GSS}	$V_{GS} = \pm 30V, V_{DS} = 0$			±100	nA
Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 10V, I_D = 1mA$	2.0		3.0	V
Forward Transfer Admittance	$\mid y_{fs} \mid$	$V_{DS} = 10V, I_D = 2A$	1.8	3.5		S
Static Drain-to-Source on State Resistance	$R_{DS(on)}$	$I_D = 2A, V_{GS} = 10V$		1.8	2.4	Ω
Input Capacitance	C_{iss}	$V_{DS} = 20V, f = 1MHz$		700		pF
Output Capacitance	C_{oss}	$V_{DS} = 20V, f = 1MHz$		90		pF
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 20V, f = 1MHz$		30		pF
Turn-ON Delay Time	$t_{d(on)}$	See specified Test Circuit.		13		ns
Rise Time	t_r	〃		15		ns
Turn-OFF Delay Time	$t_{d(off)}$	〃		160		ns
Fall Time	t_f	〃		40		ns
Diode Forward Voltage	V_{SD}	$I_S = 4A, V_{GS} = 0$			1.5	V
Diode Reverse Recovery Time	trr	$I_S = 4A, di/dt = 100A/\mu s$		120		ns

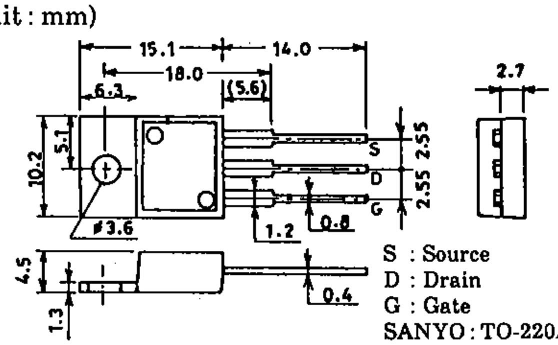
(Note) Be careful in handling the 2SK1923 because it has no protection diode between gate and source.

Switching Time Test Circuit



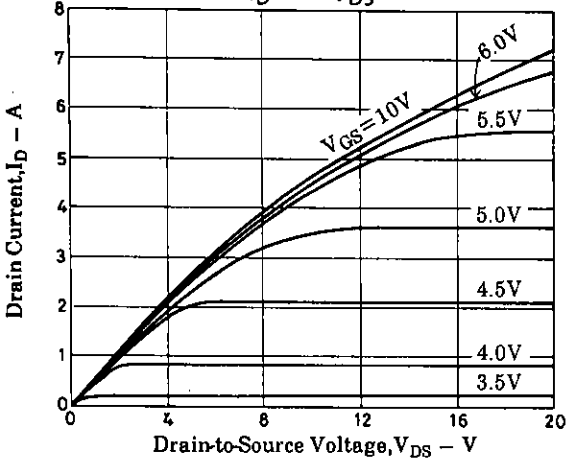
Package Dimensions 2052B

(unit : mm)

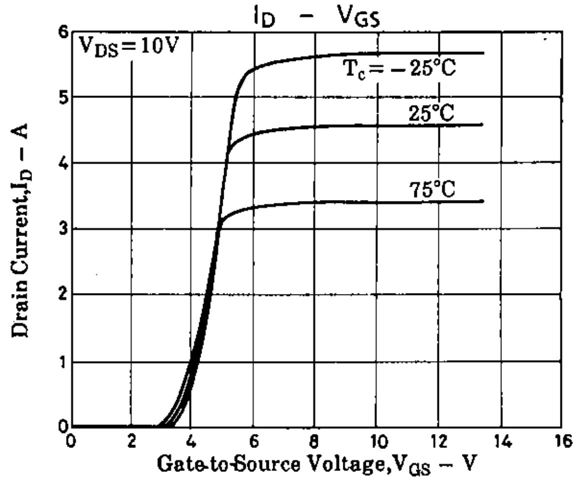


S : Source
D : Drain
G : Gate
SANYO : TO-220AB

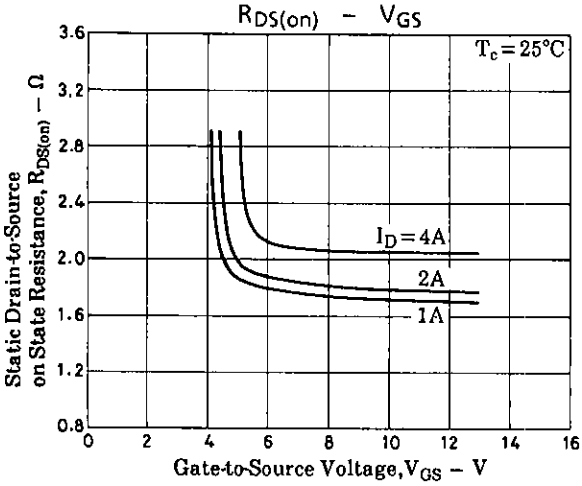
I_D – V_{DS}



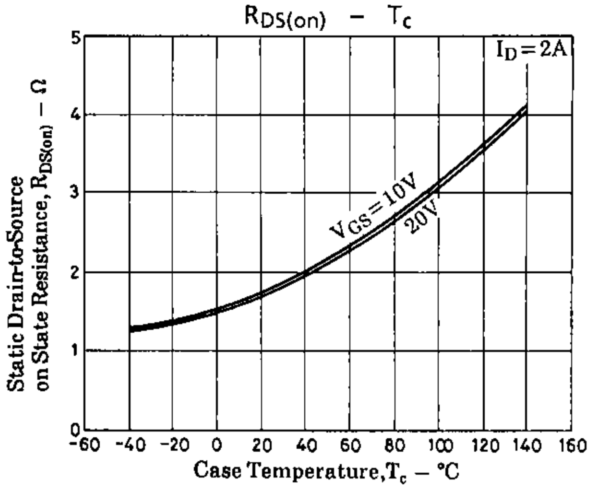
I_D – V_{GS}



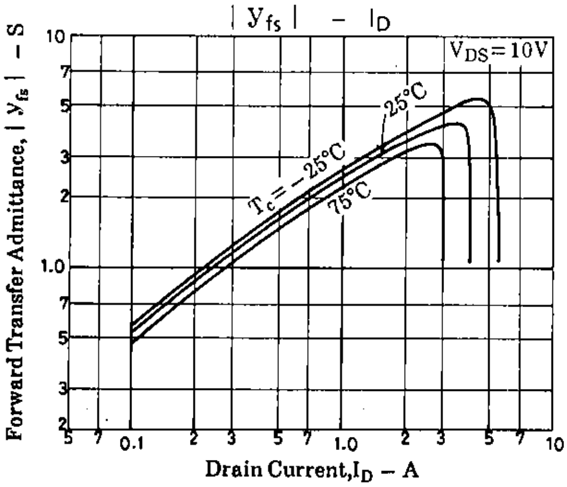
$R_{DS(on)}$ – V_{GS}



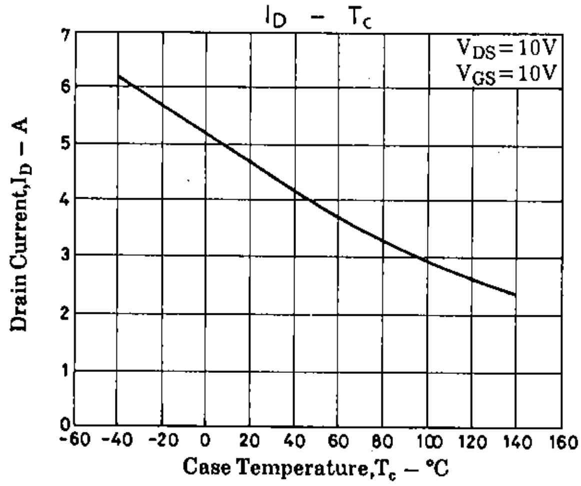
$R_{DS(on)}$ – T_c



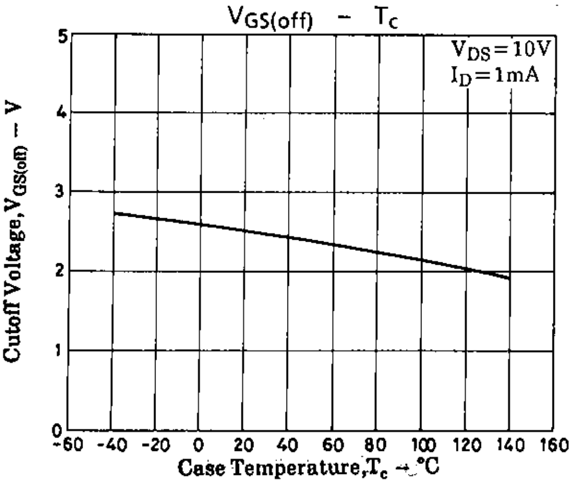
| y_{fs} | – I_D



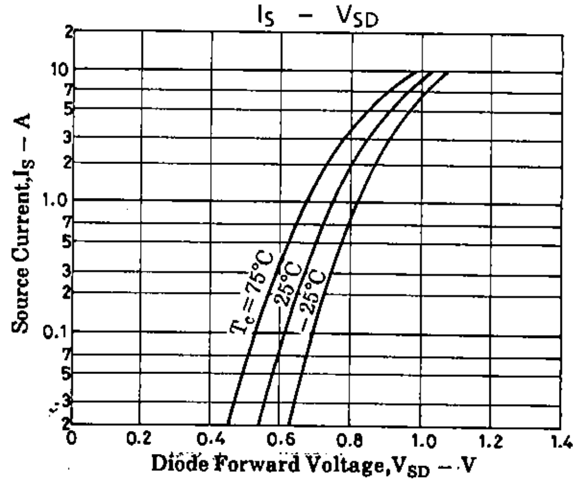
I_D – T_c



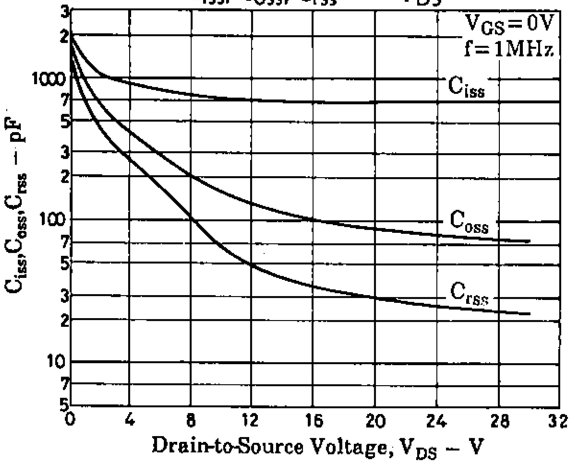
$V_{GS(off)}$ – T_c



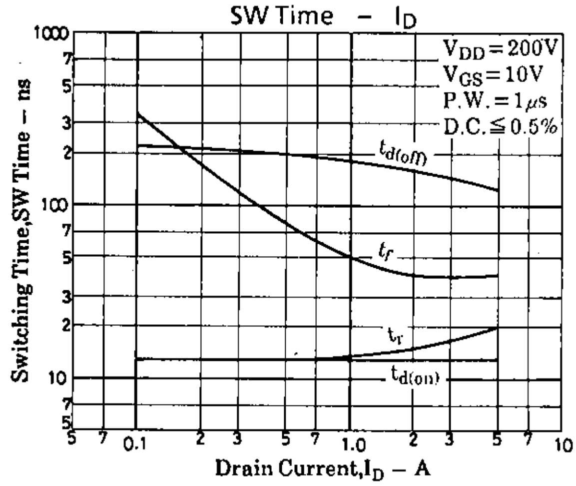
I_S – V_{SD}



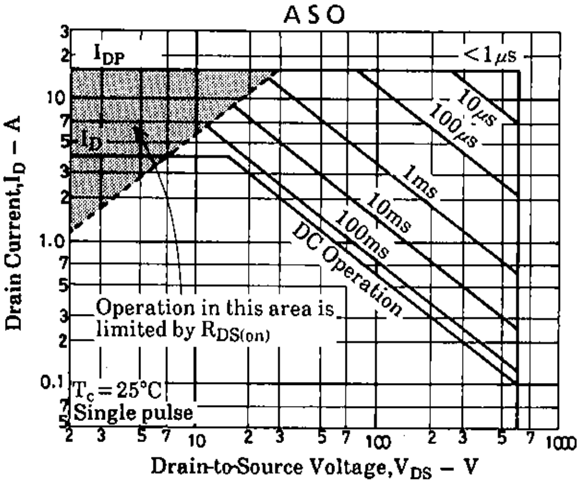
C_{iss}, C_{oss}, C_{rss} – V_{DS}



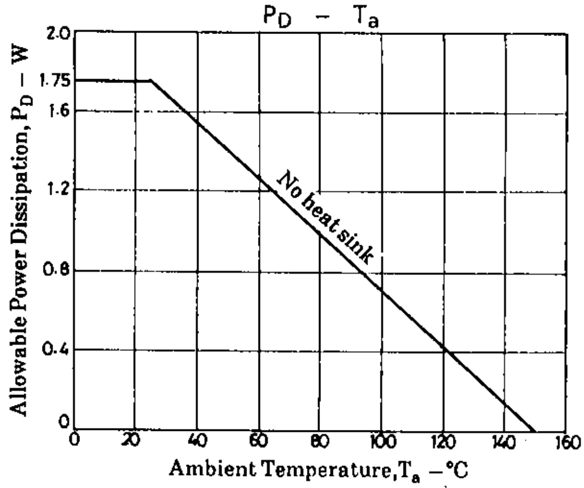
SW Time – I_D



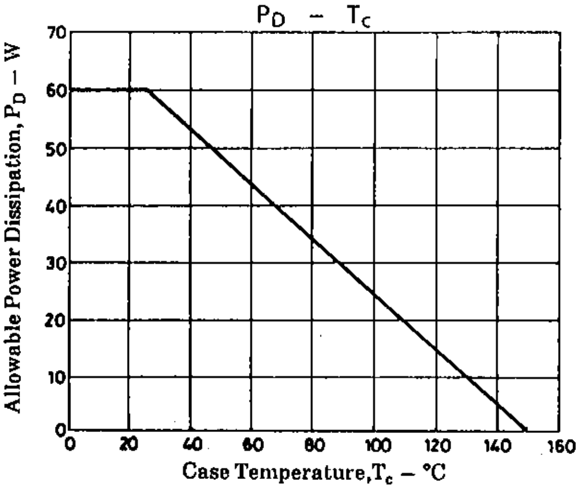
ASO



P_D – T_a



P_D – T_c



Ordering number: EN4313

No.4313

SANYO

2SK1924

N-Channel MOS Silicon FET

Very High-Speed Switching Applications

Features

- Low ON resistance.
- Very high-speed switching.
- High-speed diode (trr = 140ns).

Absolute Maximum Ratings at Ta = 25°C

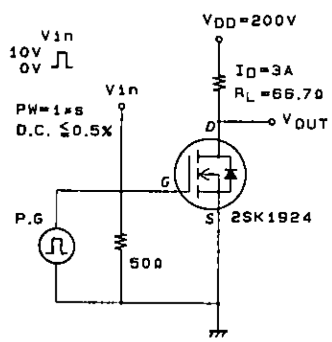
				unit
Drain-to-Source Voltage	V_{DSS}		600	V
Gate-to-Source Voltage	V_{GSS}		±30	V
Drain Current(DC)	I_D		6	A
Drain Current(Pulse)	I_{DP}		24	A
Allowable Power Dissipation	P_D		1.75	W
		T_c = 25°C	70	W
Channel Temperature	Tch		150	°C
Storage Temperature	Tstg		−55 to +150	°C

Electrical Characteristics at Ta = 25°C

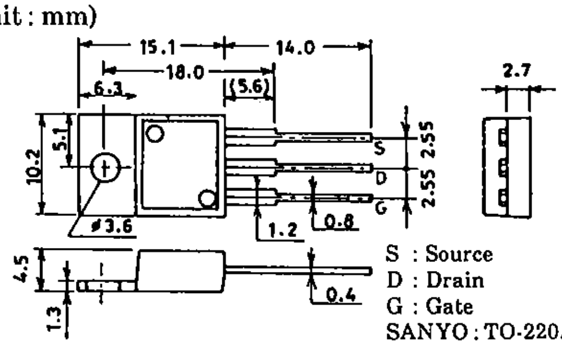
			min	typ	max	unit
D-S Breakdown Voltage	$V_{(BR)DSS}$	I_D = 10mA, V_{GS} = 0	600			V
Zero Gate Voltage Drain Current	I_{DSS}	V_{DS} = 480V, V_{GS} = 0			1.0	mA
Gate-to-Source Leakage Current	I_{GSS}	V_{GS} = ±30V, V_{DS} = 0			±100	nA
Cutoff Voltage	$V_{GS(off)}$	V_{DS} = 10V, I_D = 1mA	2.0		3.0	V
Forward Transfer Admittance	$\|y_{fs}\|$	V_{DS} = 10V, I_D = 3A	2.3	4.5		S
Static Drain-to-Source on State Resistance	$R_{DS(on)}$	I_D = 3A, V_{GS} = 10V		1.1	1.5	Ω
Input Capacitance	C_{iss}	V_{DS} = 20V, f = 1MHz		1100		pF
Output Capacitance	C_{oss}	V_{DS} = 20V, f = 1MHz		150		pF
Reverse Transfer Capacitance	C_{rss}	V_{DS} = 20V, f = 1MHz		45		pF
Turn-ON Delay Time	$t_{d(on)}$	See specified Test Circuit.		18		ns
Rise Time	t_r	〃		25		ns
Turn-OFF Delay Time	$t_{d(off)}$	〃		240		ns
Fall Time	t_f	〃		60		ns
Diode Forward Voltage	V_{SD}	I_S = 6A, V_{GS} = 0			1.5	V
Diode Reverse Recovery Time	trr	I_S = 6A, di/dt = 100A/μs		140		ns

(Note) Be careful in handling the 2SK1924 because it has no protection diode between gate and source.

Switching Time Test Circuit

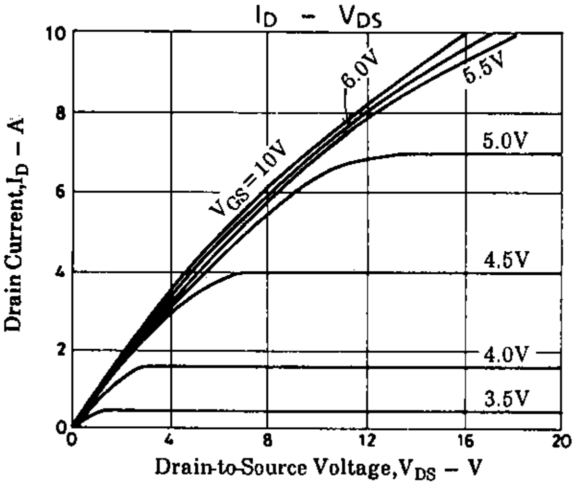


Package Dimensions 2052B
(unit : mm)

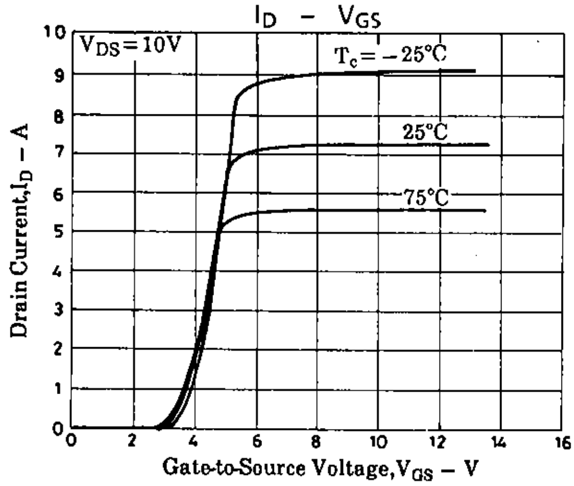


S : Source
D : Drain
G : Gate
SANYO : TO-220AB

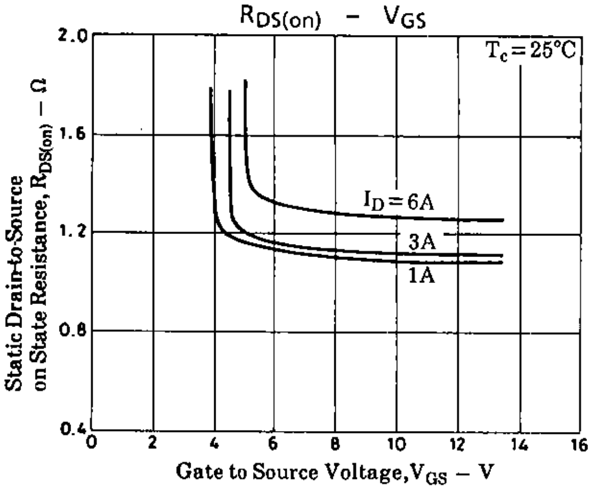
I_D – V_{DS}



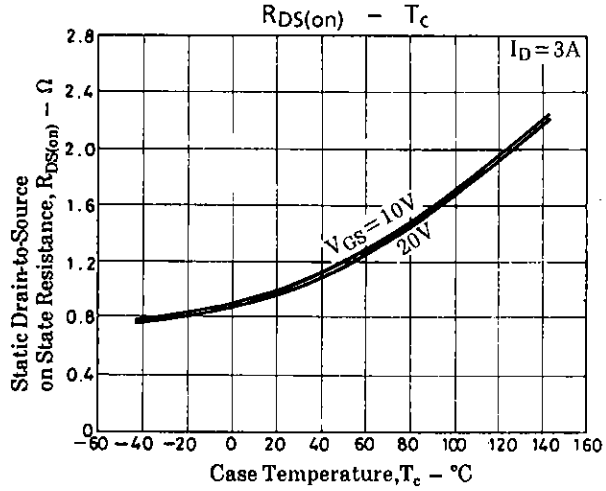
I_D – V_{GS}



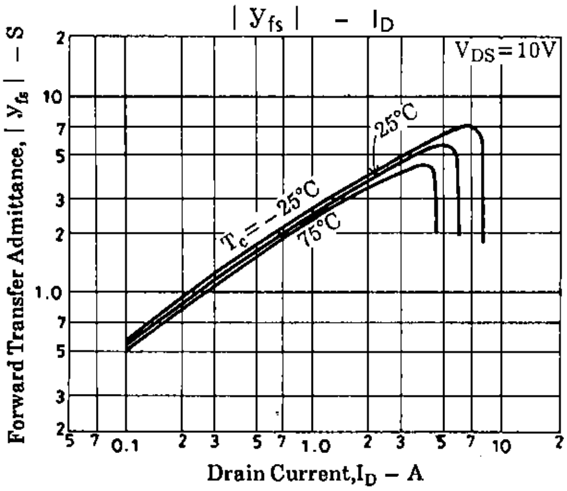
$R_{DS(on)}$ – V_{GS}



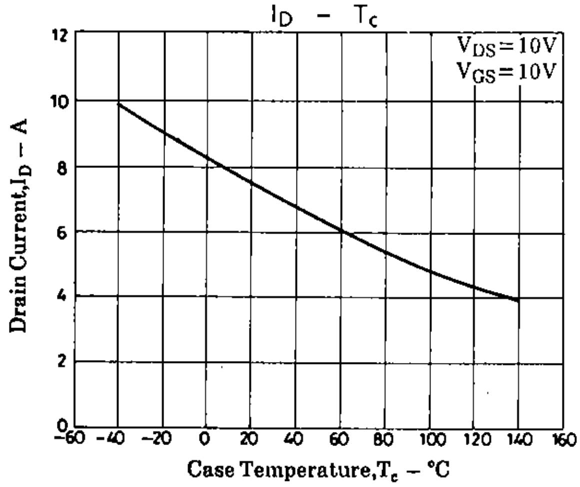
$R_{DS(on)}$ – T_c



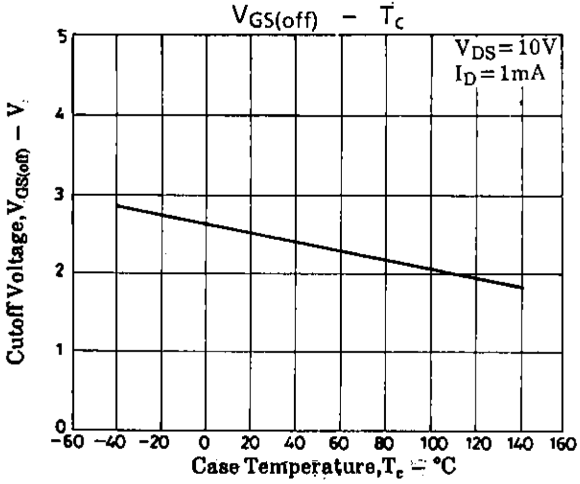
| y_{fs} | – I_D



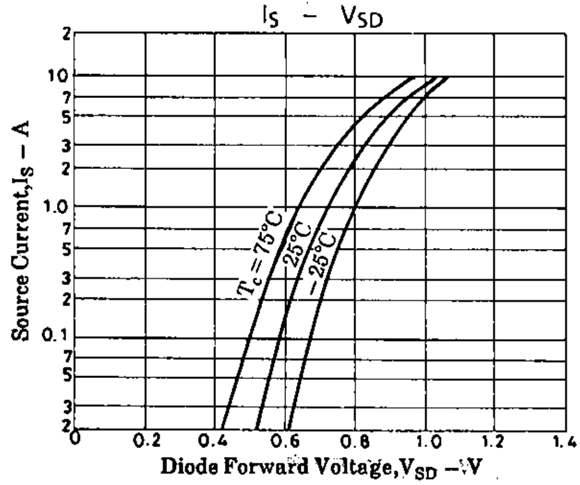
I_D – T_c



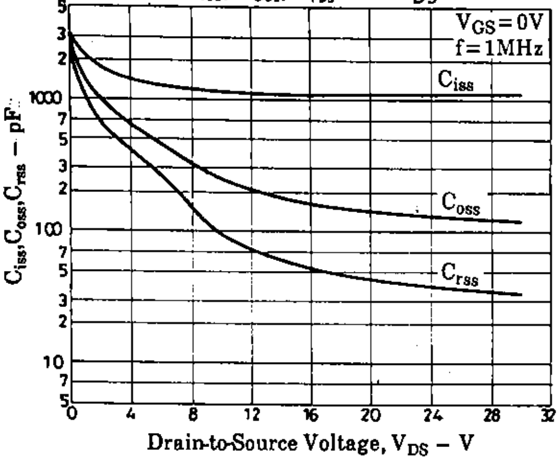
$V_{GS(off)}$ – T_c



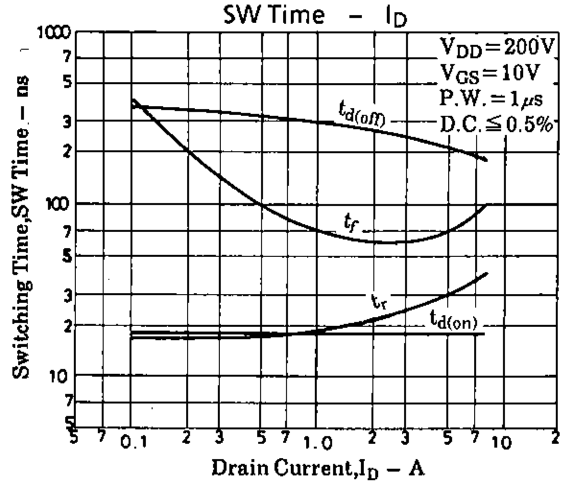
I_S – V_{SD}



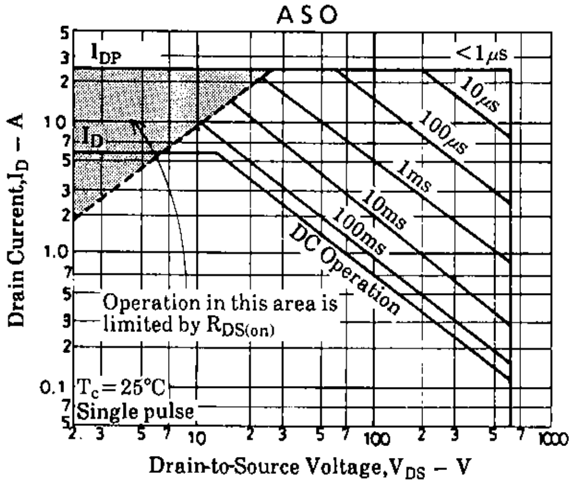
Ciss, Coss, Crss – VDS



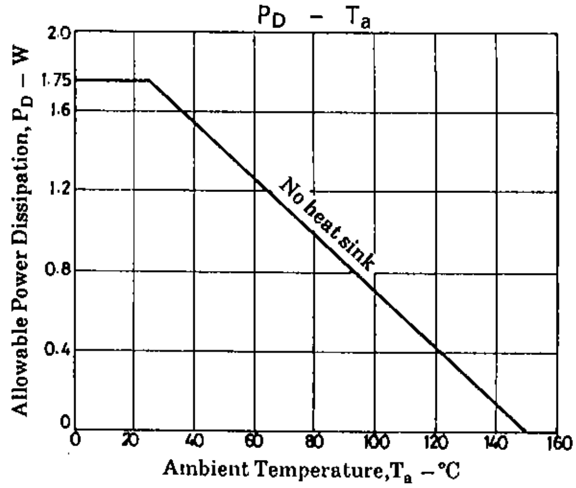
SW Time – ID



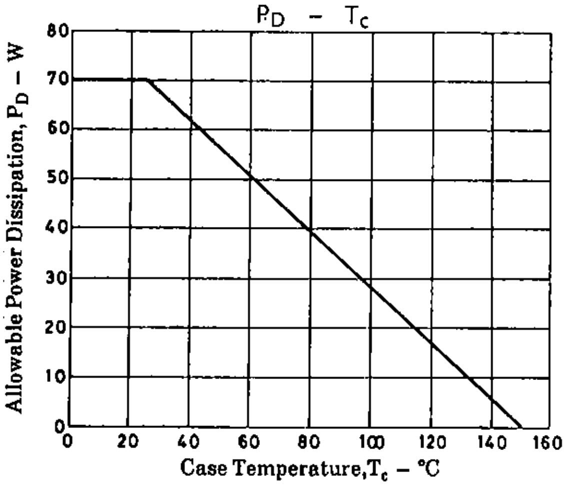
ASO



PD – Ta



PD – Tc



Ordering number: EN4314

No.4314

SANYO

2SK1925

N-Channel MOS Silicon FET

Very High-Speed Switching Applications

Features

- Low ON resistance.
- Very high-speed switching.
- High-speed diode (trr = 150ns).

Absolute Maximum Ratings at Ta = 25°C

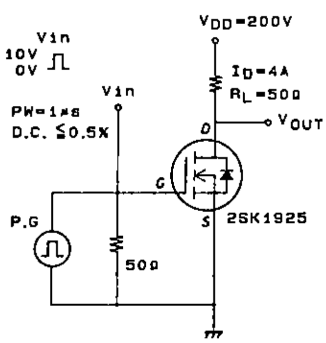
				unit
Drain-to-Source Voltage	V_{DSS}		600	V
Gate-to-Source Voltage	V_{GSS}		±30	V
Drain Current(DC)	I_D		8	A
Drain Current(Pulse)	I_{DP}		32	A
Allowable Power Dissipation	P_D		2.5	W
		$T_c = 25°C$	120	W
Channel Temperature	Tch		150	°C
Storage Temperature	Tstg		−55 to +150	°C

Electrical Characteristics at Ta = 25°C

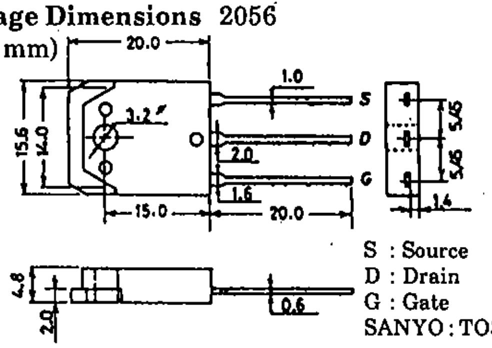
			min	typ	max	unit
D-S Breakdown Voltage	V_{DSS}	$I_D = 10mA, V_{GS} = 0$	600			V
Zero Gate Voltage Drain Current	I_{DSS}	$V_{DS} = 480V, V_{GS} = 0$			1.0	mA
Gate-to-Source Leakage Current	I_{GSS}	$V_{GS} = \pm 30V, V_{DS} = 0$			±100	nA
Cutoff Voltage	$V_{GS(off)}$	$V_{DS} = 10V, I_D = 1mA$	2.0		3.0	V
Forward Transfer Admittance	$\lvert y_{fs} \rvert$	$V_{DS} = 10V, I_D = 4A$	2.8	5.5		S
Static Drain-to-Source on State Resistance	$R_{DS(on)}$	$I_D = 4A, V_{GS} = 10V$		0.9	1.2	Ω
Input Capacitance	C_{iss}	$V_{DS} = 20V, f = 1MHz$		1500		pF
Output Capacitance	C_{oss}	$V_{DS} = 20V, f = 1MHz$		190		pF
Reverse Transfer Capacitance	C_{rss}	$V_{DS} = 20V, f = 1MHz$		50		pF
Turn-ON Delay Time	$t_{d(on)}$	See specified Test Circuit.		20		ns
Rise Time	t_r	〃		35		ns
Turn-OFF Delay Time	$t_{d(off)}$	〃		350		ns
Fall Time	t_f	〃		100		ns
Diode Forward Voltage	V_{SD}	$I_S = 8A, V_{GS} = 0$			1.5	V
Diode Reverse Recovery Time	trr	$I_S = 8A, di/dt = 100A/\mu s$		150		ns

(Note) Be careful in handling the 2SK1925 because it has no protection diode between gate and source.

Switching Time Test Circuit



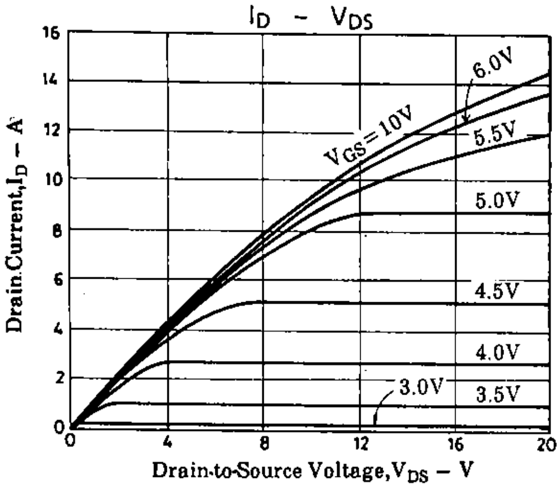
Package Dimensions 2056
(unit : mm)



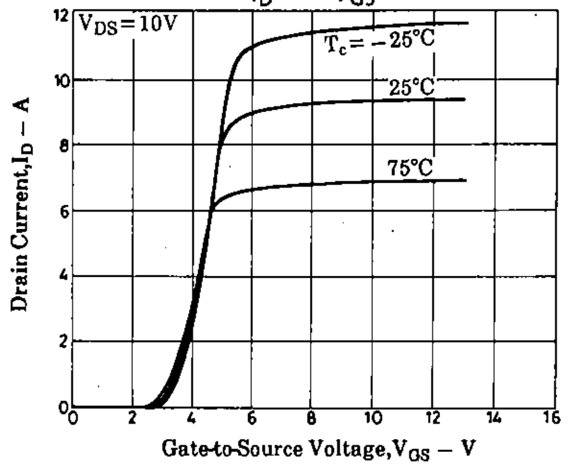
S : Source
D : Drain
G : Gate
SANYO : TO3PB

SANYO Electric Co., Ltd. Semiconductor Business Headquarters
TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110 JAPAN

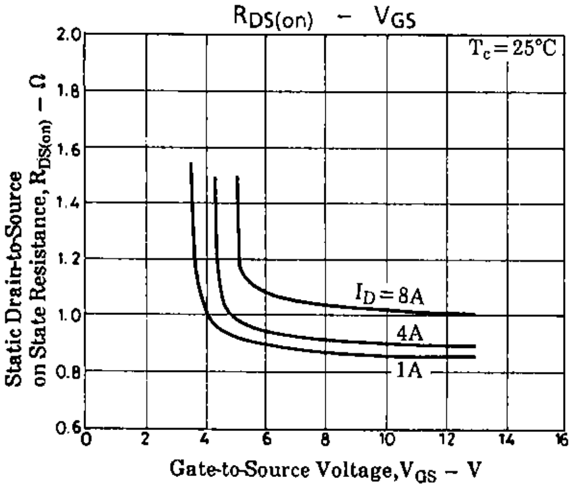
I_D – V_{DS}



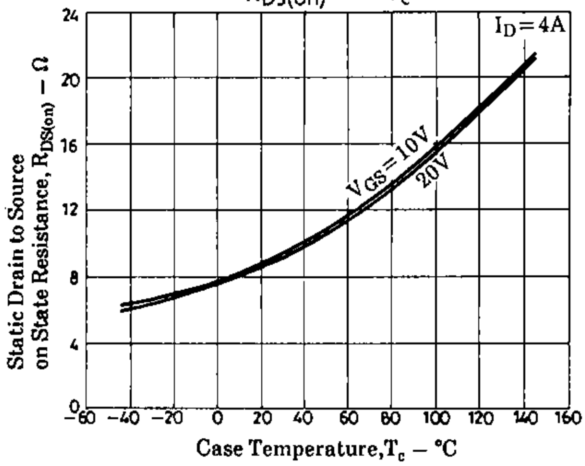
I_D – V_{GS}



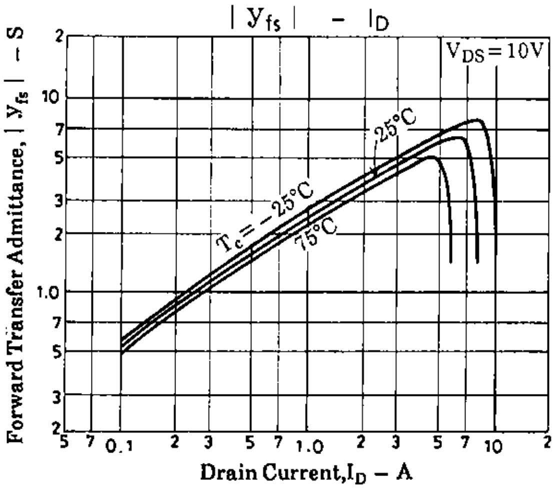
$R_{DS(on)}$ – V_{GS}



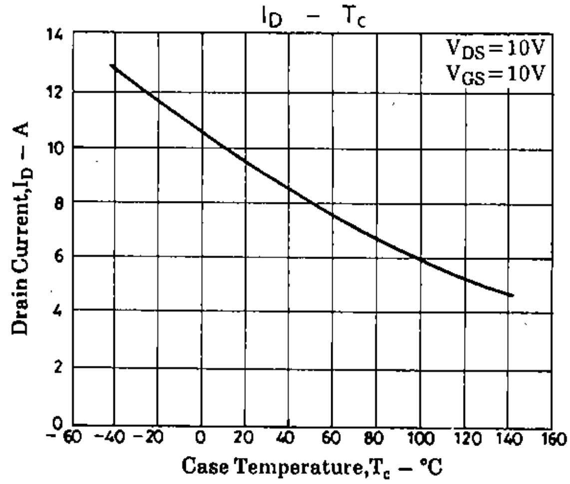
$R_{DS(on)}$ – T_c



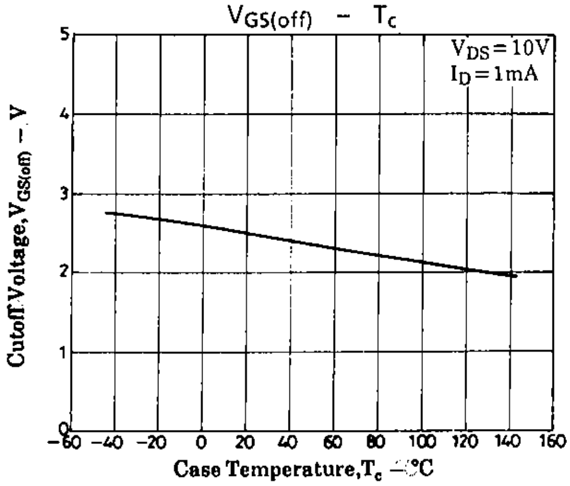
$|y_{fs}|$ – I_D



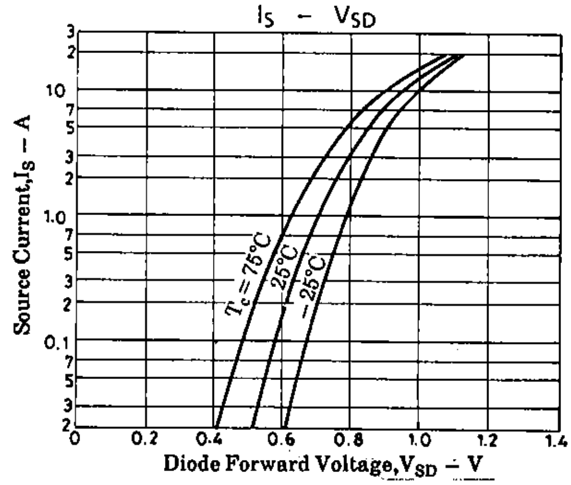
I_D – T_c



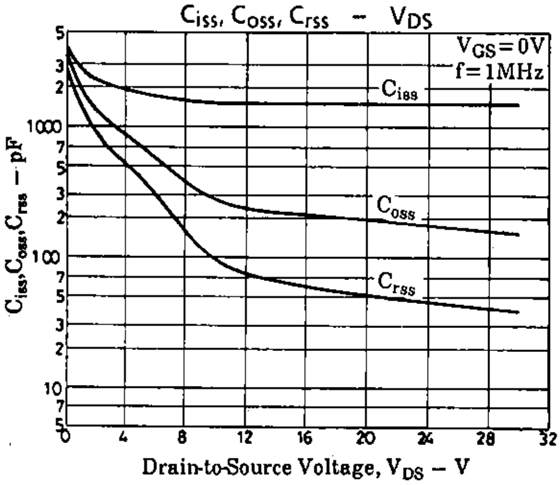
$V_{GS(off)}$ – T_c



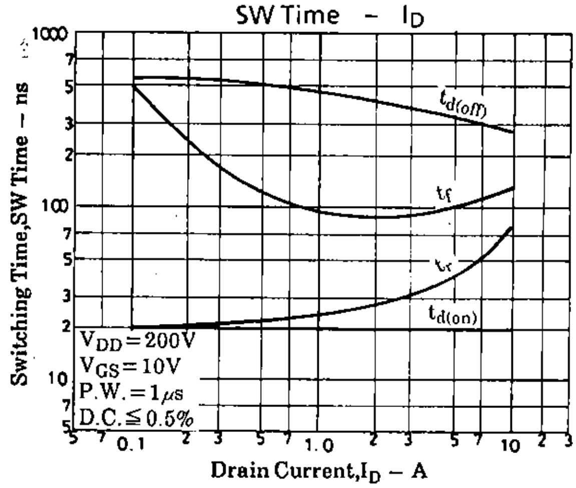
I_S – V_{SD}



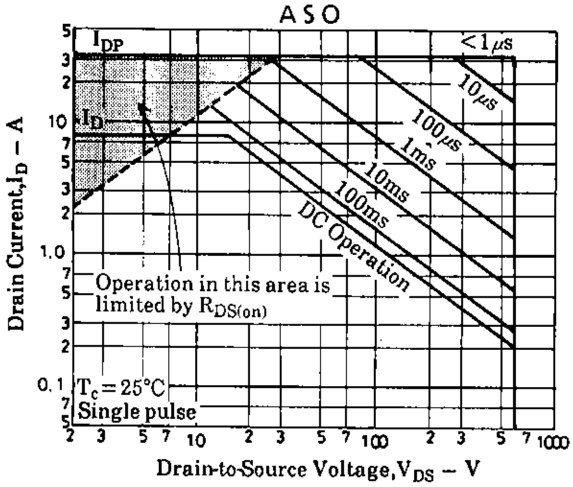
$C_{iss}, C_{oss}, C_{rss}$ − V_{DS}



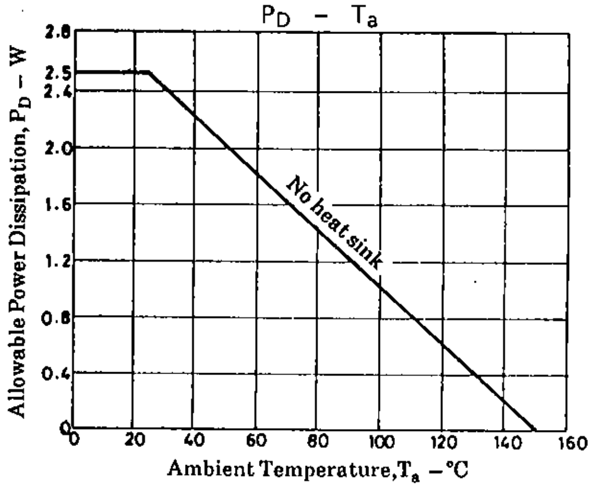
SW Time − I_D



ASO



P_D − T_a



P_D − T_c