

MV SERIES

COMPONENT PERFORMANCE

TRANSISTOR PERFORMANCE

Parameter	Small NPN, 1X	Medium NPN	Large NPN
Useful Current Range	10nA-10mA	100nA-30mA	100nA-90mA
Current Gain, h_{FE}	80-400	80-400	80-400
Matching of h_{FE}	$\pm 10\%$	$\pm 10\%$	$\pm 10\%$
Matching of V_{BE}	$\pm 5mV$ maximum	$\pm 4mV$ maximum	$\pm 3mV$ maximum
Collector Breakdown Voltage, V_{CEO}	40V minimum	40V minimum	40V minimum
Collector-Base Leakage	5pA typical	2pA typical	10pA typical
Base-Emitter Breakdown, V_{EBO}	7.3V typical	7.3V typical	7.3V typical
Cutoff Frequency, f_T	450MHz typical	450MHz typical	450MHz typical
Saturation Resistance	10-30 ohms	5-20 ohms	3-8 ohms

Parameter	Lateral PNP	Vertical PNP
Useful Current Range	10nA-1mA	10nA-5mA
Current Gain, h_{FE}	30-250	75-250
Matching of h_{FE}	$\pm 10\%$	$\pm 10\%$
Matching of V_{BE}	$\pm 5mV$ maximum	$\pm 5mV$ maximum
Collector Breakdown Voltage, V_{CEO}	50V minimum	50V minimum
Collector Base Leakage	7pA typical	7pA typical
Base-Emitter Breakdown, V_{EBO}	40V minimum	7.3V typical
Cutoff Frequency, f_T	4.5MHz typical	13MHz typical
Saturation Resistance	300-900 ohms	10-40 ohms

PASSIVE COMPONENT PERFORMANCE

Diffused Resistor Performance

P Base Diffused Resistors

Resistor Values	300 ohms 900 ohms 1.8K ohms
Resistor Tolerance	$\pm 25\%$
Temperature Coefficient	$+0.2\%/^{\circ}C$ typ.
Matching	
Equal (1:1) Ratio	$\pm 2\%$
Non-Equal Ratio	$\pm 6\%$

N+ Emitter Diffused Resistors

Resistor Values	15, 20, 25 ohms
Resistor Tolerance	$\pm 25\%$
Temperature Coefficient	$+0.13\%/^{\circ}C$ typ.

Implanted Resistor Performance

Resistor values	10K, 50K ohms typ.
Resistor Tolerance	$\pm 25\%$
Temperature Coefficient	$0.33\%/^{\circ}C$ typ.
Breakdown Voltage	40V min.

Capacitor Performance

Capacitor Value	5pF typ.
Capacitor Tolerance	$\pm 25\%$

Diode Performance

Forward Voltage	0.7V typ.
Forward Voltage Matching	$\pm 5mV$ max.
Temperature Coefficient, Forward	$-1.8V/^{\circ}C$ typ.
Reverse Breakdown Voltage	
Emitter-Base (NPN)	7.3V typ.
Temp. Coeff., Reverse	$+2.9V/^{\circ}C$ typ.
Emitter-Base (PNP)	40V min.

MV SERIES

MACROCHIP MV FAMILY COMPONENT CHART						
	Cell	MVA	MVC	MVE	MVG	MVJ
Array Cell	1	4	6	9	12	20
NPN-2X	4	22	30	42	54	86
NPN-medium	-	2	3	3	4	5
NPN-large	-	2	3	3	4	5
NPN-pad 2X	-	8	8	12	12	16
NPN (Resistor Pocket)	-	4	4	6	6	8
PNP/NPN (Monistor)	4	22	30	44	56	88
Substrate PNP	-	2	3	3	4	5
Base Resistance:						
900 ohms	16	100	138	206	263	428
1800 ohms	16	98	136	236	303	476
300 ohms	4	16	24	36	48	80
400 ohms	-	4	4	6	6	8
Total Base Res.	44.4K	272.8K	377.8K	623.4K	798.9K	1269.2K
Implant Resistance						
10K ohms	12	68	92	138	174	280
50K ohms	-	4	4	6	6	8
Total Impl. Res.	120K	880K	1120K	1680K	2040K	3200K
Total Resistance	164.4K	1152.8K	1497.8K	2303.4K	2838.9K	4469.2K
Capacitors (5PF)						
(Or use as pads)	-	4	4	6	6	8
Pads	-	16	20	24	28	36
Size (Mils)	-	93x79	93x101	132x101	132x123	164x145

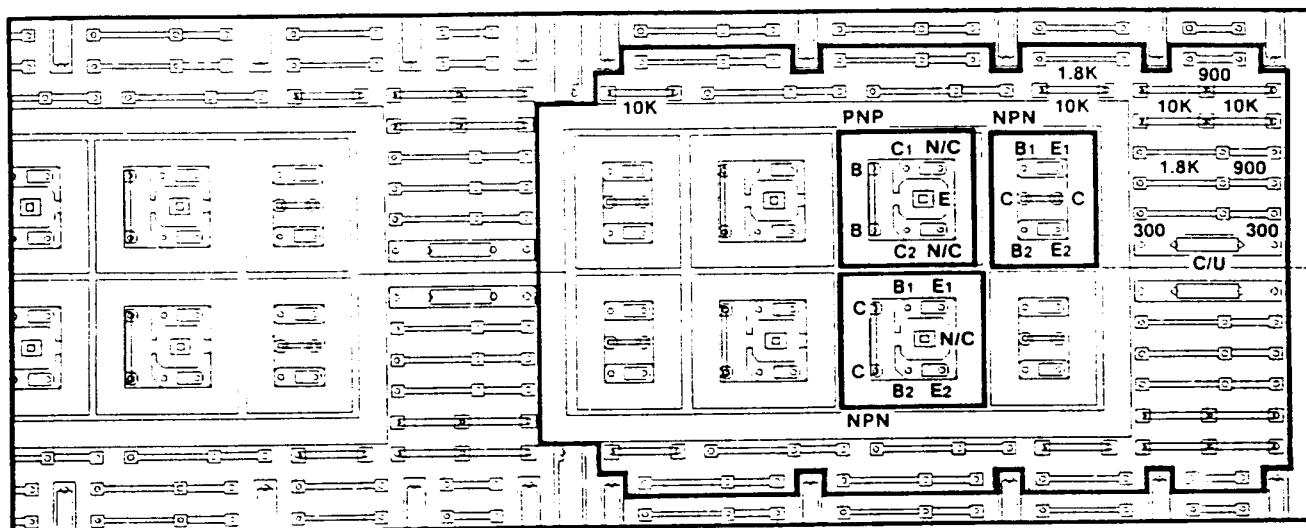
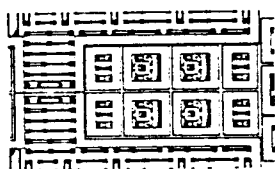


Figure 3-8. Basic Array Cell with Components outlined.

THE MV SERIES MACROCHIP



MV Series Macrochip Array Cell

All MV Series Macrochips feature identical array cells which contain dedicated NPN transistors, monistors for use as either NPN or lateral PNP transistors, diffused resistors with basic values of 300 ohms, 900 ohms and 1800 ohms, and ion-implanted resistors equal to 10K ohms. These array cells are the basic design blocks used in the library of macro designs made available for circuit designers.

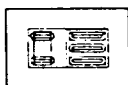
Small NPN Transistor (2X)

All array cells use common-collector dual NPN transistors as primary gain elements. The independent base and emitter areas allow 2:1 area matching to be achieved as well as providing a more efficient use of the basic silicon area. The double collector contacts the low impedance N+ region to be used as a crossunder resistor.



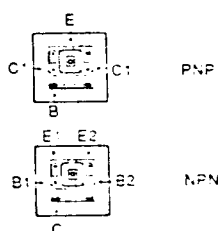
Medium NPN Transistor

The medium NPN transistor is a peripheral component with lengthened rectangular emitters to provide increased current capability. The double collector contacts allow the low impedance N+ region to be used as a crossunder resistor.



Large NPN Transistor

The large NPN transistor is a peripheral component with additional long rectangular emitters designed to provide high current capability. This is a common-collector dual NPN transistor with a 5:1 emitter area ratio. The six collector contacts allow the low impedance N+ region to be used as a crossunder resistor.



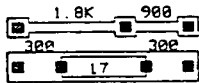
Monistor (PNP/NPN)

For increased versatility, each array cell contains monistors instead of dedicated lateral PNP transistors. The monistor is a multi-purpose device which may be connected to function as either a lateral PNP transistor or an NPN transistor. When connected as a lateral PNP transistor, the

monistor has two collectors. The two base contacts allow the low impedance N+ region to be used as a crossunder resistor. When connected as an NPN transistor, the monistor is a common-collector dual NPN transistor with emitter areas equal to those of the dedicated small NPN transistor. The dual collector allows the low impedance N+ region to be used as a crossunder resistor.

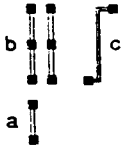
Vertical PNP Transistor

The vertical PNP transistor, or the "substrate PNP", is a peripheral component providing gain at higher current levels. Because the substrate serves as the collector of this device, its use is limited to situations in which the collector is connected to the negative power supply.



Diffused Resistors

Each array cell and the peripheral and bus areas contain base diffused resistors with three basic values of 300 ohms, 900 ohms, and 1800 ohms. The resistors are designed to provide closely matched values which can be connected in parallel or series as desired. Note that two resistor strings, each containing one 900 ohm and one 1800 ohm resistor, can be used to create eighteen different-value resistors.



Ion-Implanted Resistors

Each array cell and each peripheral resistor pocket contains ion-implanted resistors designed to provide 10K ohms each. These appear both individually (a), and in resistor strings of two (b). Each peripheral resistor pocket contains a 50K ohm ion-implanted resistor (c) in addition to the 10K ohm resistors. All resistors on the MV Macrochip are useful up to the rated 40 volts.

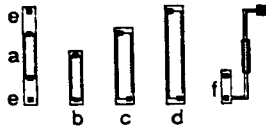


Peripheral Resistor Pocket

Each MV Macrochip has at least four individual resistor pockets in the peripheral area. These pockets may be biased at voltages different from the main positive power supply for added versatility. Each pocket contains diffused resistors, ion-implanted resistors, and an NPN transistor of which the collector is the N-type epi resistor pocket itself. This peripheral resistor pocket NPN has an emitter area equal to that of a single emitter of the dedicated small NPN transistor.

Crossunders

There are four different N+ crossunders and two P crossunders, each of which provides a low impedance:

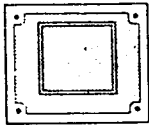


- (a) Cell crossunder (N+)
- (b) Small bus crossunder (N+)
- (c) Medium bus crossunder (N+)
- (d) Large bus crossunder (N+)
- (e) Cell base diffused resistor (P)
- (f) Peripheral resistor pocket base diffused resistor (P)



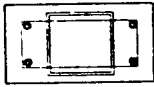
Epi-Pinch Resistor

Each MV Macrochip contains one Epi-pinched resistor using the epitaxial layer as the resistance. This provides a high value resistor which is useful to the rated 40 volts.



Capacitor

Each MV Macrochip contains at least four oxide capacitors which provide 5pF of capacitance each, constant up to the rated 40 volts. These capacitors are particularly useful as on-chip compensation capacitors to provide stable operation of amplifier circuits, reducing the need for external components. When not used as capacitors, these structures may be used as bonding pads.



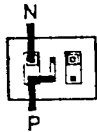
Bonding Pads and Grid Structure

All MV Macrochips include dedicated bonding pad locations which allow electrical connections of the circuit to the outside world. All dedicated bonding pads have crossunders positioned underneath them. The layout also contains a grid structure which indicates where metal traces can be run on the IC to avoid violation of design rules.



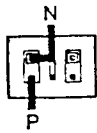
Bonding Pad NPN Transistor

Every MV Macrochip has at least eight bonding pad NPN transistors, which are common-collector dual NPN transistors with emitter areas equal to those of the dedicated small NPN transistor. These devices also serve as isolated bonding pads.



Diodes

Diodes, as a separate circuit element, are not included on the MV Macrochips. However, any transistor or monistor can be used as a circuit diode. The preferred circuit connection is to short the transistor controller and base. The resultant diode will thus have the forward and reverse characteristics of the transistor emitter-base junction.



Zener Diodes

Zener diodes can be formed by using any transistor or monistor. The NPN emitter-base junction, when used in reverse bias, has a breakdown voltage of approximately 7 volts. Such zener structures offer a low temperature coefficient and good matching on the same chip. The preferred circuit connection is short the transistor collector and emitter.

P-DIFFUSED RESISTORS

Each array cell and the peripheral and bus areas contain base diffused resistors with three basic values of 300 ohms, 900 ohms and 1800 ohms. The resistors are designed to provide closely matched values which can be connected in parallel or series as desired. Note that two resistor strings, each containing one 900 ohm and one 1800 ohm resistor, can be used to create eighteen different-value resistors.

Tolerances and Temperature Coefficients

Since none of these resistors can be pretested, trimmed, or selected, their variation is necessarily larger compared to that of a discrete resistor. Also, the material from which these resistors are made, diffused silicon, is not optimal for this purpose, resulting in a larger temperature coefficient compared to both thin film and carbon resistors.

On the other hand, all resistors on a chip are made within the same block of material and are in close proximity, thus, the ratios between the various resistors tend to be very close and stable with temperature.

Isolation

All resistors are in a common epitaxial N-type island. To keep each resistor electrically isolated, the N-island must be connected to a voltage equal to or more positive than the highest resistor voltage. Normally, this condition is achieved by connecting the N-island to the most positive supply voltage. Each MV chip has at least one main N-island and at least four peripheral N-islands to allow resistors in them to be operated at voltages greater than V_+ . For this case, the connection between the islands has to be severed and the V_+ contact of each island has to be tied to a voltage equal or higher than the highest voltage on any resistor within.

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
P Base Diffused Resistor					
900 ohms	VBIAS = 10V	675		1125	Ω
1800 ohms	VBIAS = 10V	1350		2250	Ω
300 ohms	VBIAS = 10V	225		375	Ω
.9K/.9K% Matching	(VBIAS = Voltage across the resistor)			2	%
.9K/1.8K% Matching				3	%
.9K/3K% Matching				12	%
1.8K/3K% Matching				12	%

ELECTRICAL	Change of Ratio Accuracy from Wafer to Wafer.....	2%
CHARACTERISTICS	Temperature Coefficient.....	+0.2%/°C
(TA = +25°C)	Variation in Resistor Ratio with Temperature.....	±0.01%/°C
	Variation in Resistor Ratio with Voltage.....	+0.01%/V

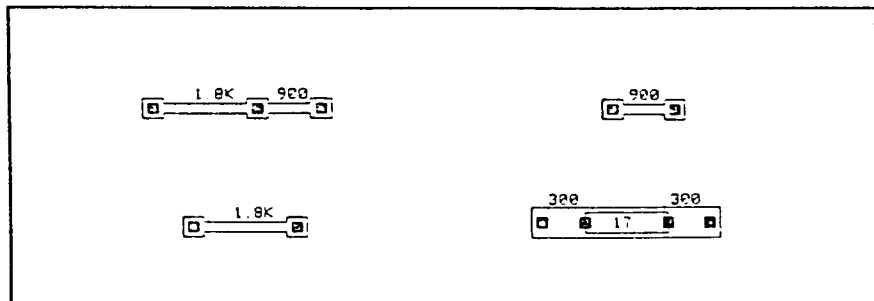
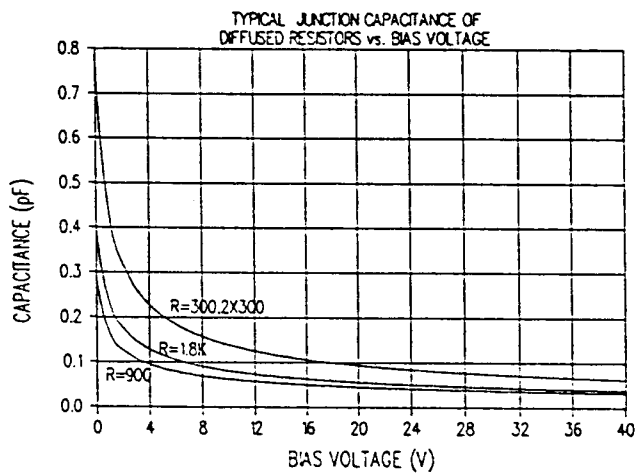
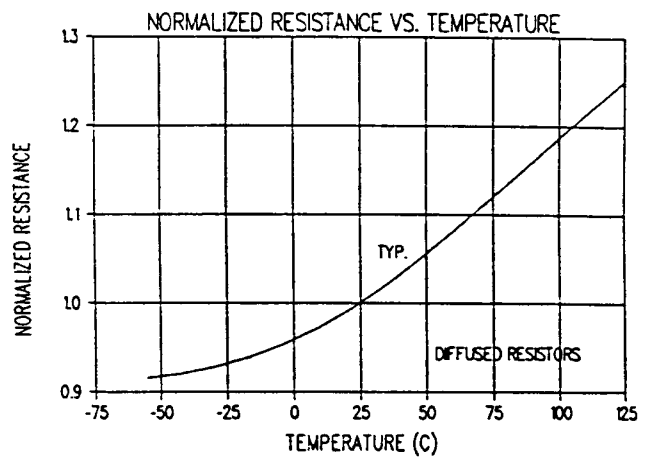
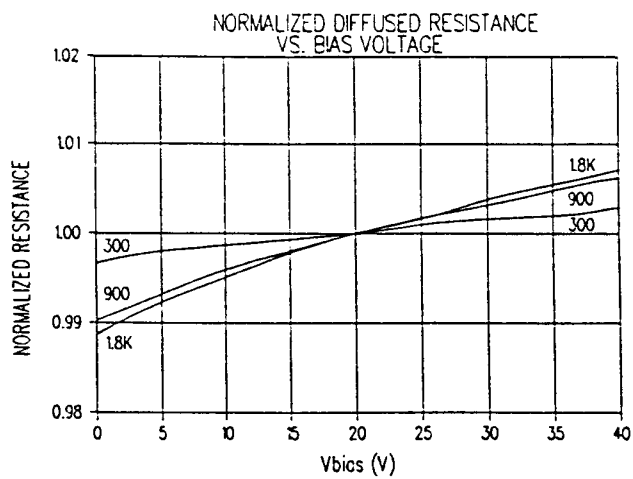


Figure 3-9. Diffused Resistors.



ION-IMPLANTED RESISTORS

Ion-Implanted Resistors

Each array cell and each peripheral resistor pocket contains ion-implanted resistors designed to provide 10K ohms each. These appear both individually (a), and in resistor strings of two (b). Each peripheral resistor pocket contains a 50K ohm ion-implanted resistor (c) in addition to the 10K ohm resistors. All resistors on the MV Macrochip are useful up to the rated 40 volts.

Bias Voltage Effect on Ion-Implanted Resistors

The effect of bias voltage on the value of the ion-implanted resistors is significantly greater than it is with the diffused resistors. While this effect over the entire 40 volt range is typically about 2% for diffused resistors, it amounts to more than 12% for ion-implanted resistors. Consult the graphs for specific design data.

MOS Effect on Ion-Implanted Resistors

A metal trace crossing the bulk of the implanted resistor will increase its value depending on the area covered and the voltage between the metal and the underlying resistor portion. This effect occurs in addition to and effectively independent of the other effects described in the graphs.

In the graphs the curve for 1 standard stripe gives the increase for a metal trace 10 microns wide. The line labeled "MAX.COVERAGE" shows the effect when the whole resistor bar is covered by continuous metal, except for the minimum spaces necessary for resistor contacts not to be connected to this metal. The horizontal axis scale is the voltage difference between the metal and the low voltage end of the resistor.

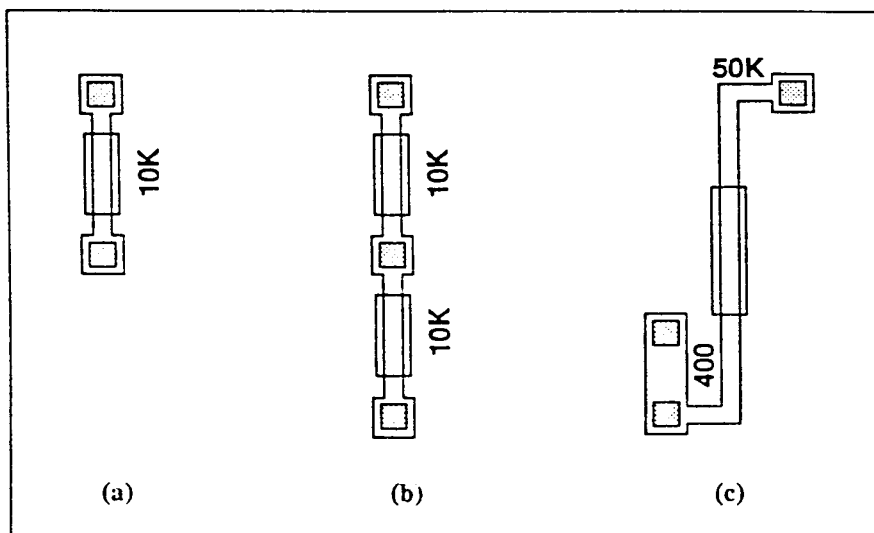
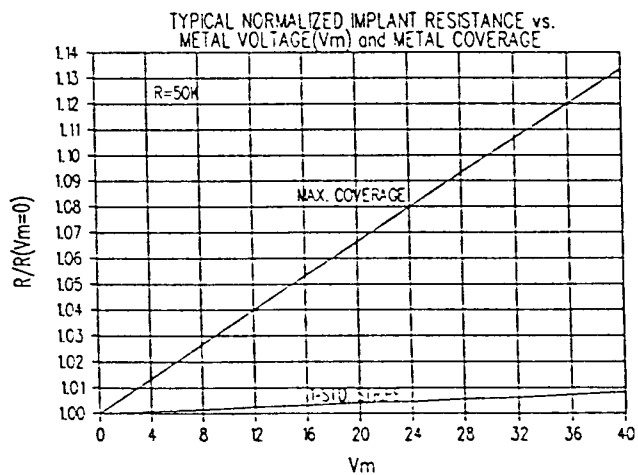
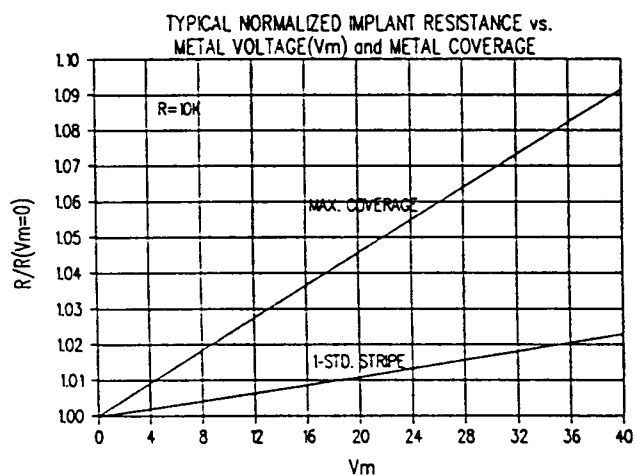
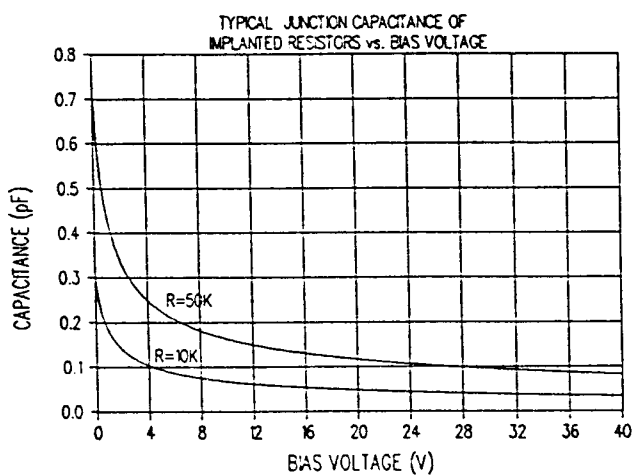
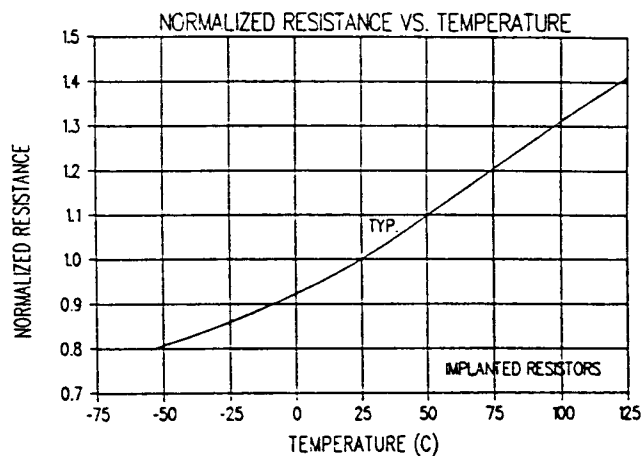
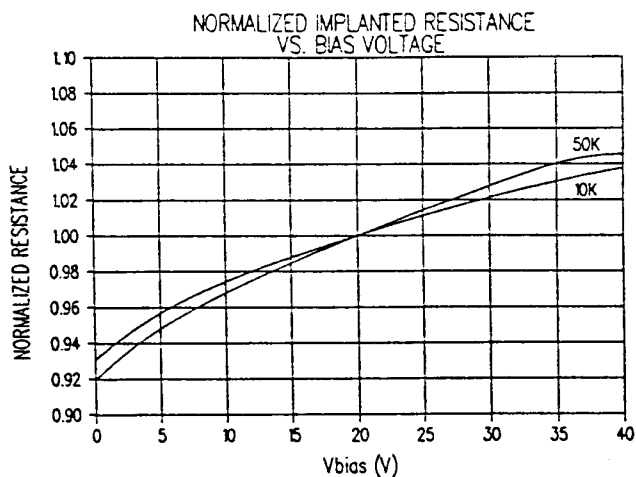


Figure 3-10. Ion-Implanted Resistors.



EPI-PINCH RESISTOR

Epi-Pinch Resistor

Each MV Macrochip contains one Epi-pinch resistor. This provides a high value resistor which is useful up to the rated 40 volts. This structure is actually two resistors in series. It uses the high resistivity of the epitaxial layer and is formed by placing a P-base layer completely over a strip of epi-material bordered by the isolation diffusion. The resistor is formed by the N-epi material, reduced in its crosssection by the surrounding P-material. All points of this resistor should always be biased positive with respect to the substrate. Careful attention should be given to the design data provided in this section, in order to avoid accidentally turning this device off.

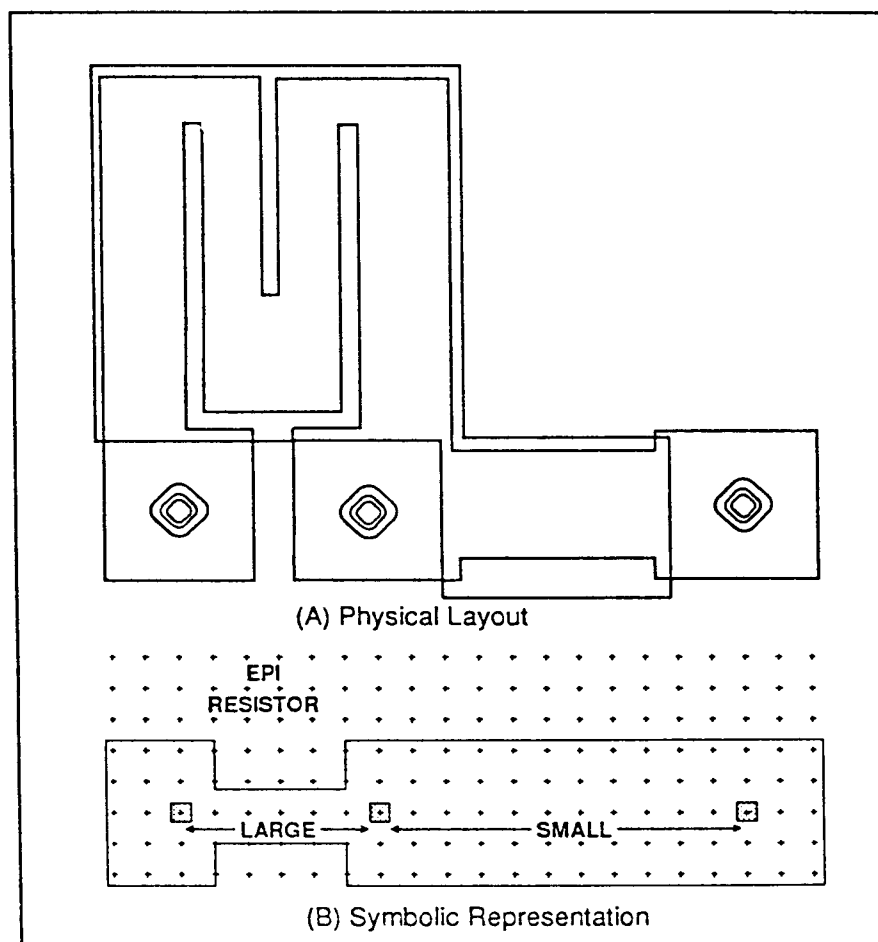


Figure 3-11. Epi Pinch Resistor.

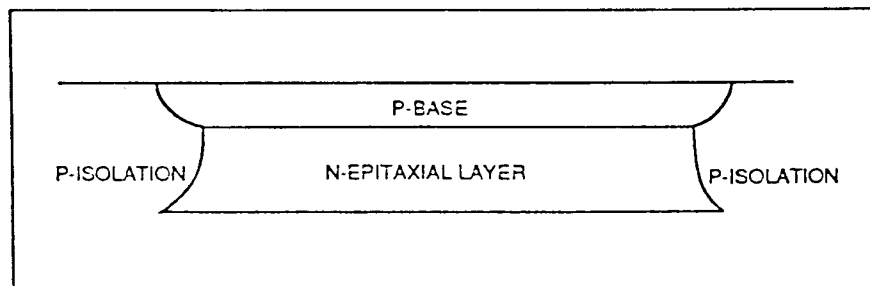
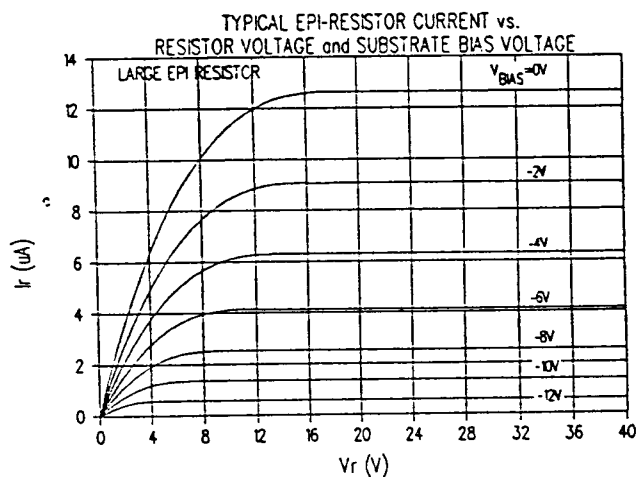
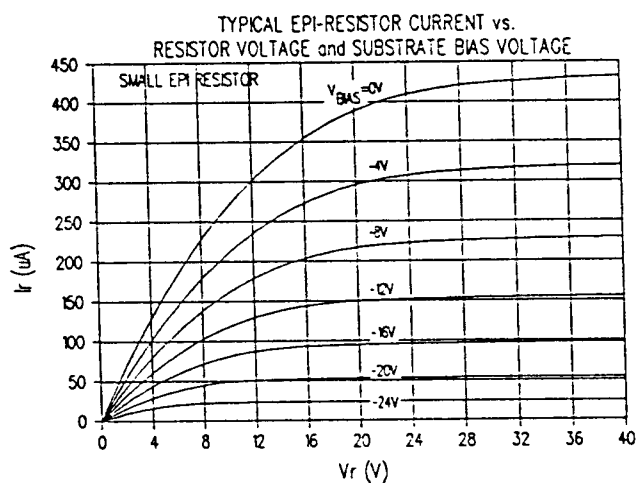
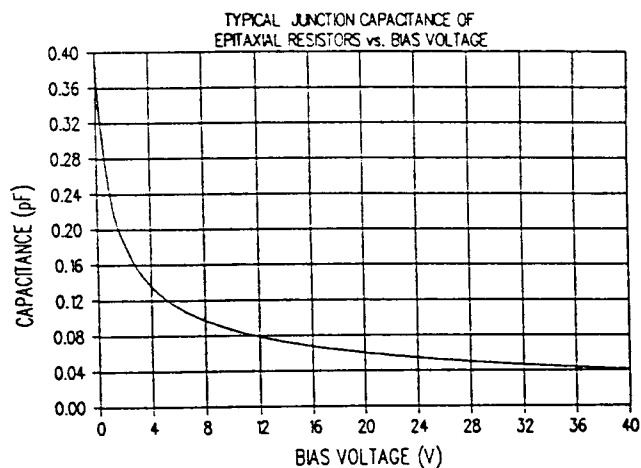
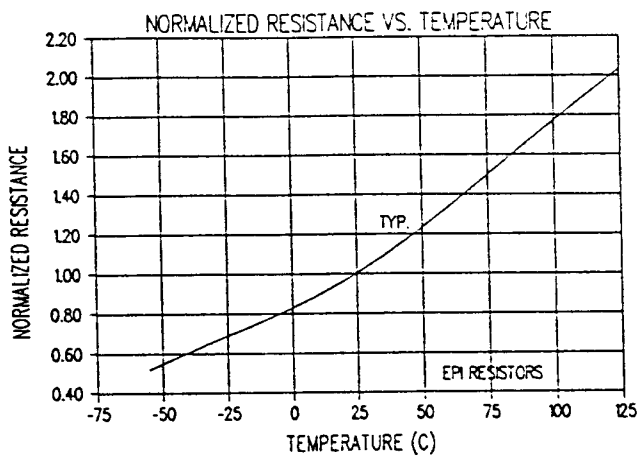


Figure 3-12. Cross Section of the Epi Pinch Resistor.



CAPACITOR ("CAPAD")

The oxide capacitors which are present on all MV Macrochips provide 5 pF of capacitance each, constant up to the rated 40 volts. The metal which forms the top plate of the capacitor is the same metal layer which is patterned to interconnect the various components on the chip. Thus, the standard metal mask may be used to customize the area of the capacitor metal to obtain values of capacitance lower than the nominal 5pF.

If none of the CAPADs on a chip are used as capacitors, then all of them are available for use as bonding pads. When used as bonding pads, the CAPADs are cut down to standard bonding pad size. Metal traces which are routed over the thin oxide of the capacitor will have some capacitance with respect to the capacitor N+, as will the pad itself. This capacitance will be quite small, and may be estimated by comparing the area of such metal to the total area of a standard 5pF capacitor.

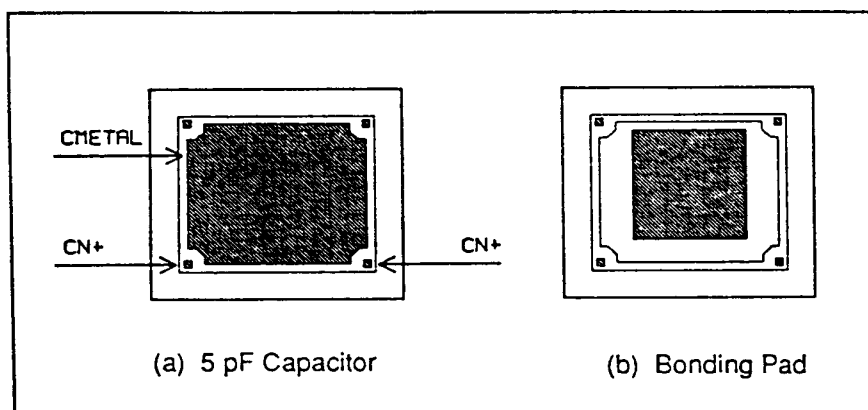


Figure 3-13. MV CAPAD USES.

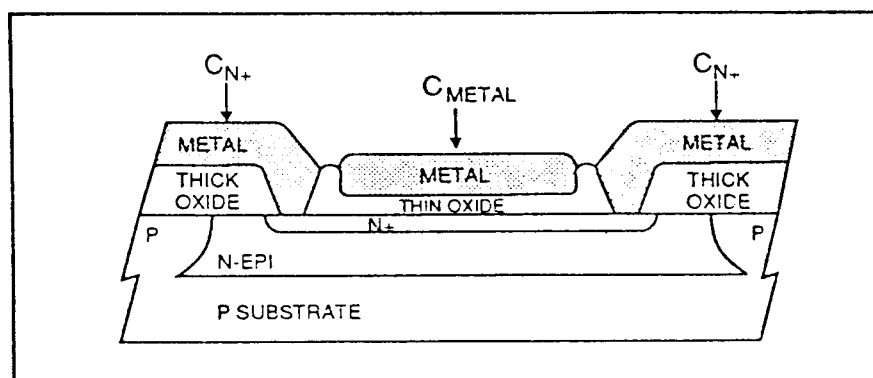
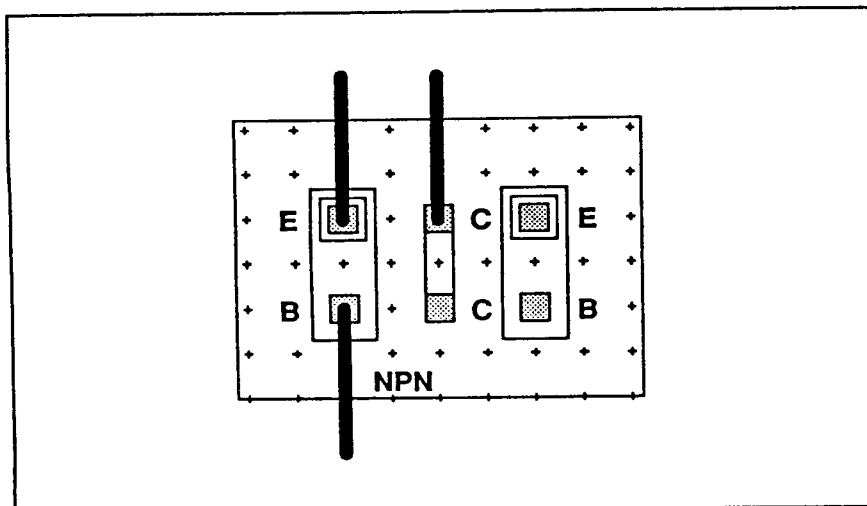


Figure 3-14. The MV CAPAD Cross-Section.

**The MV 1X NPN
TRANSISTOR
("1X NPN")**

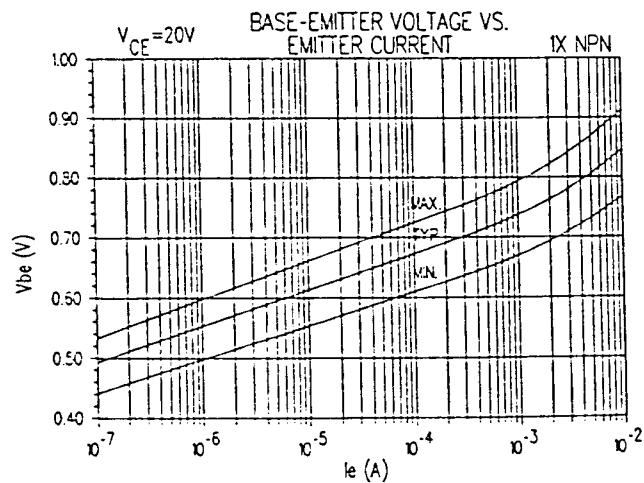
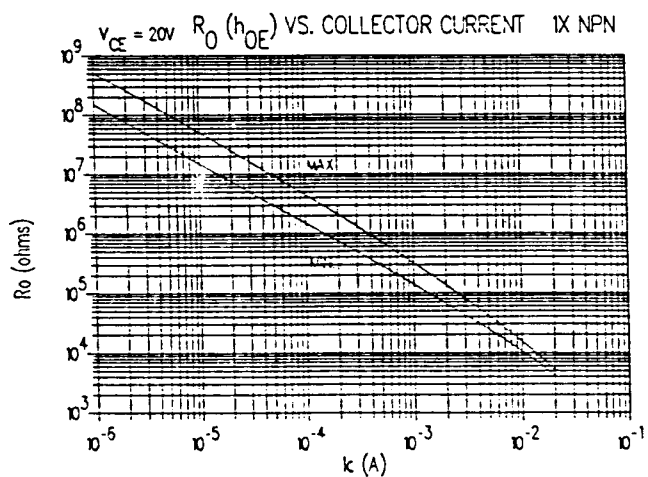
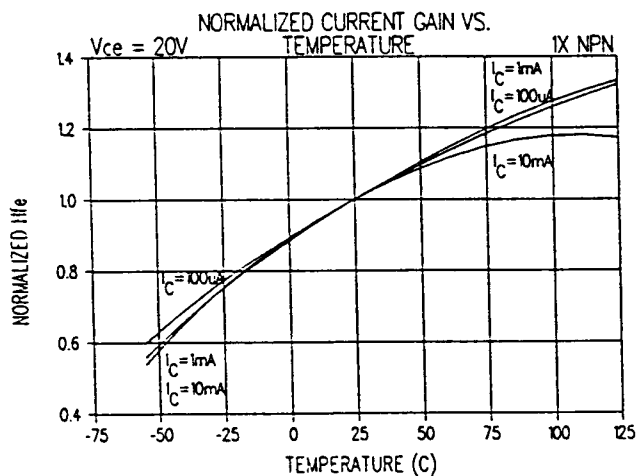
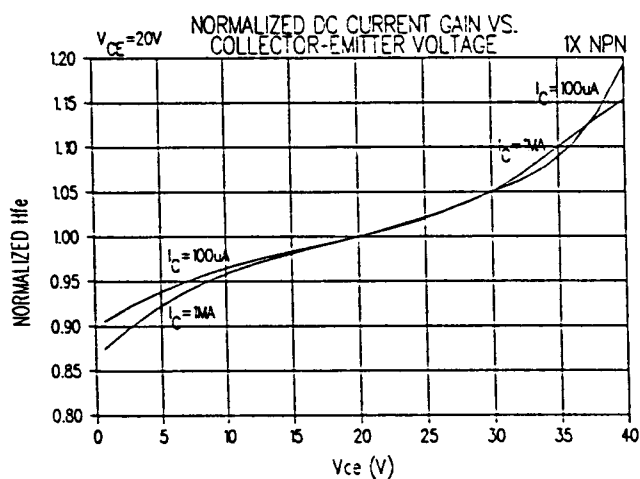
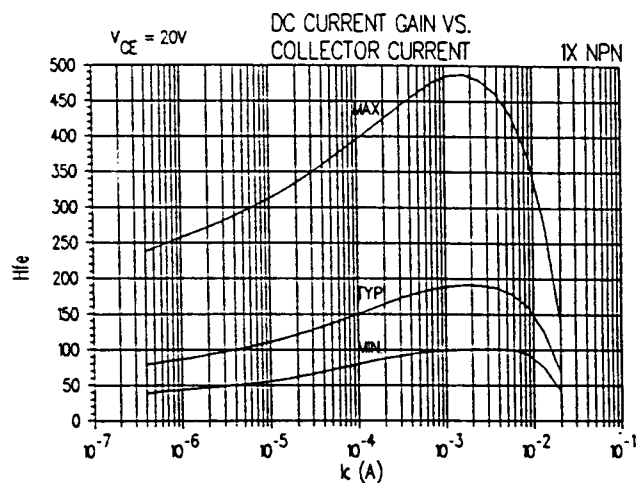
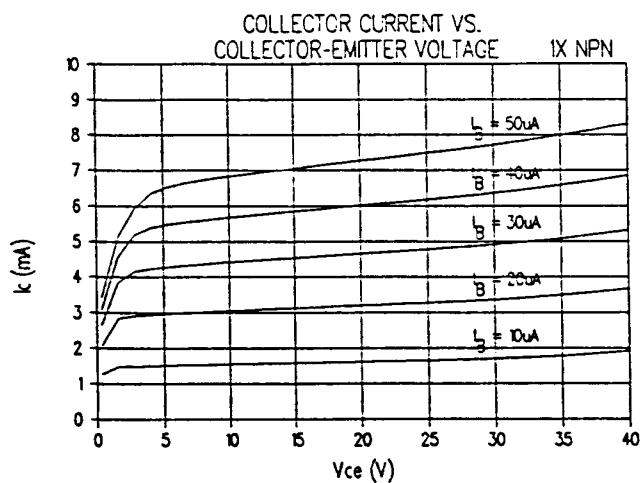
The MV 1X NPN transistor is actually just a 1X connection of a 2X NPN transistor. It is convenient to have data available for this 1X connection, and to refer to it as a "1X NPN". This data is useful for the NPN transistor in the peripheral resistor pocket, and for the 1X connections of the Monistors and bonding pad NPN transistors as well.

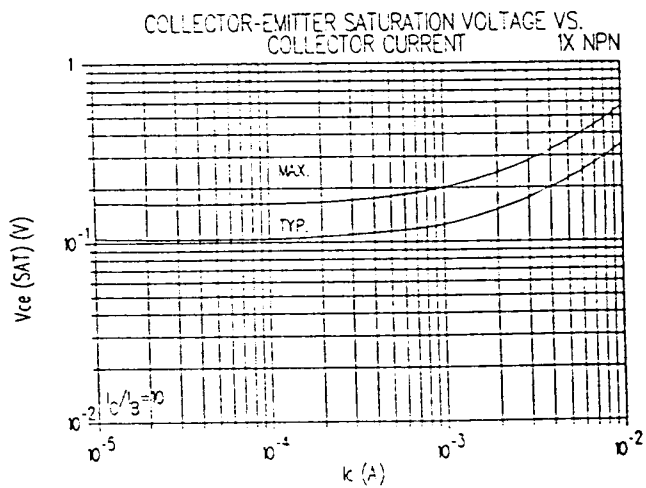
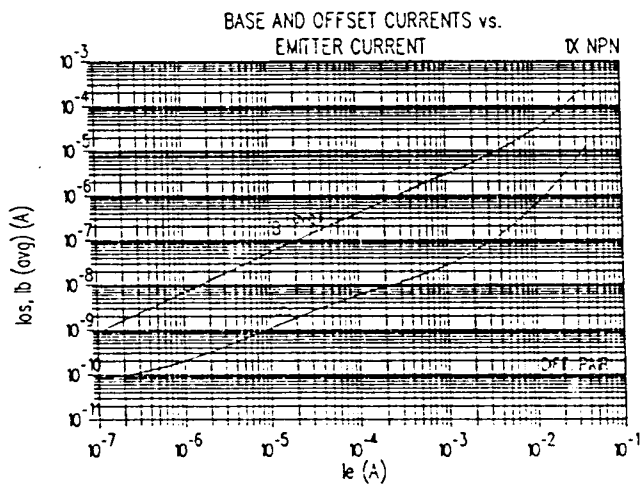
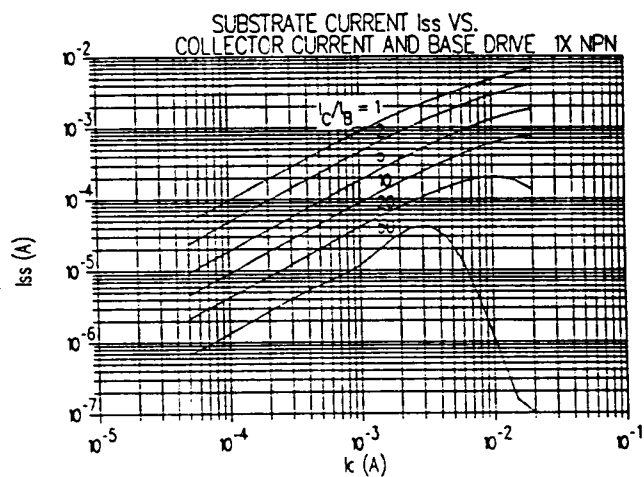
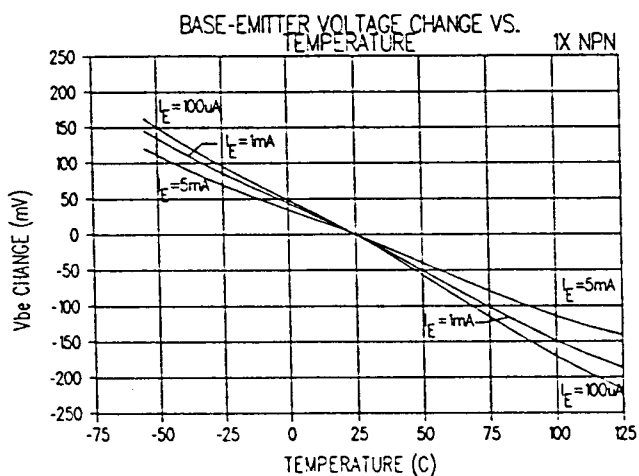
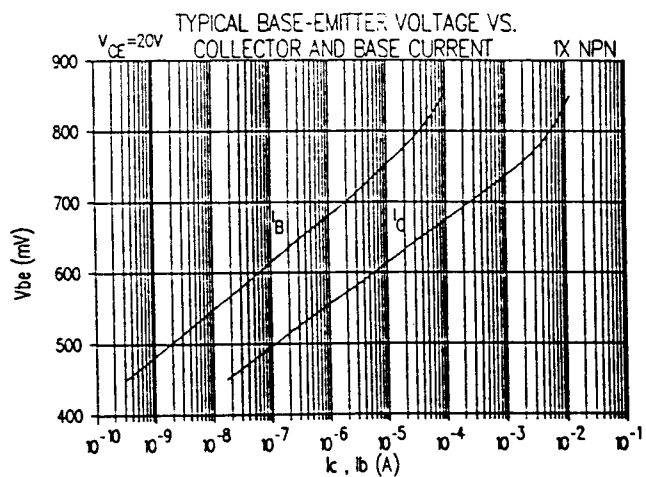
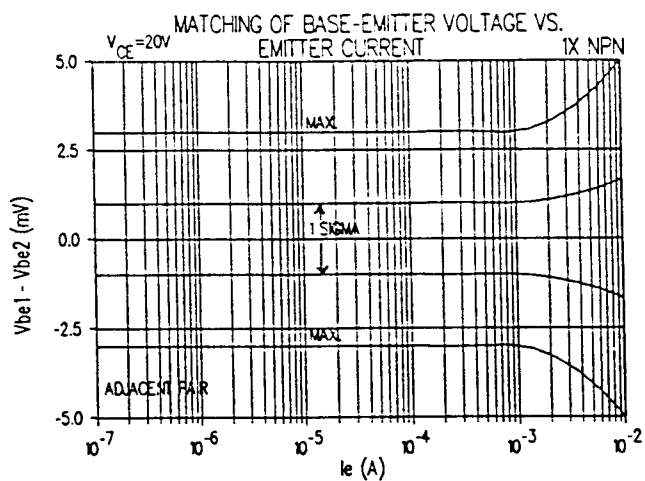


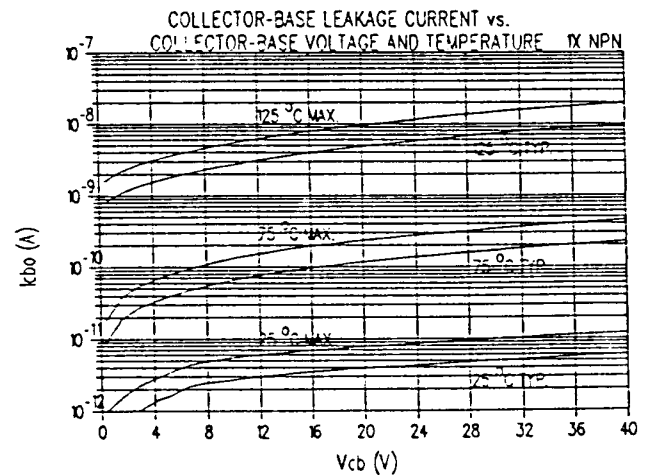
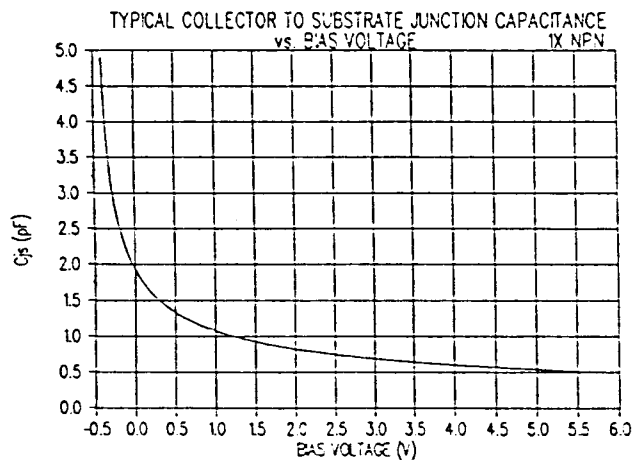
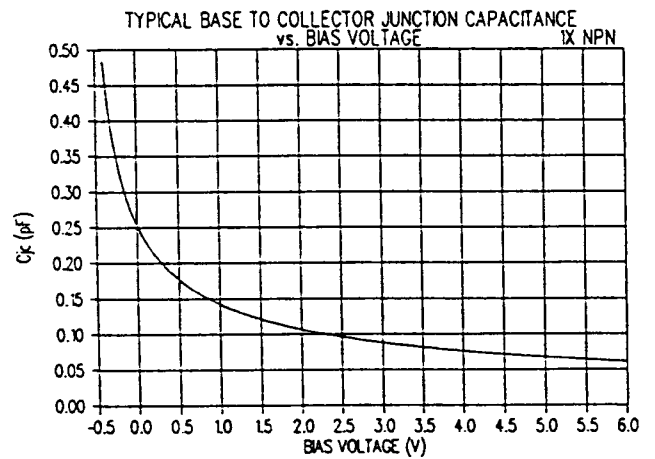
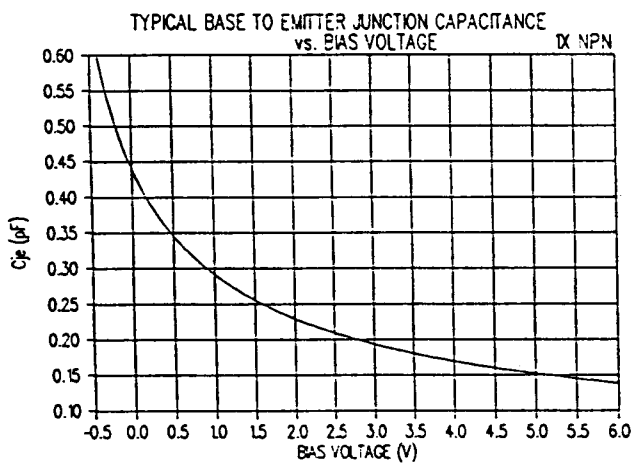
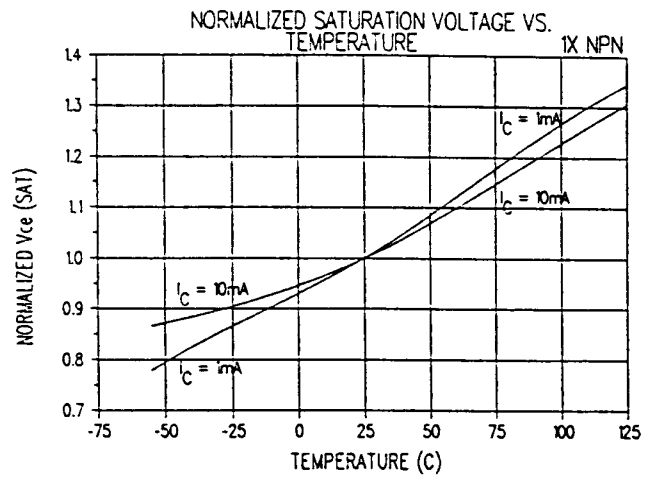
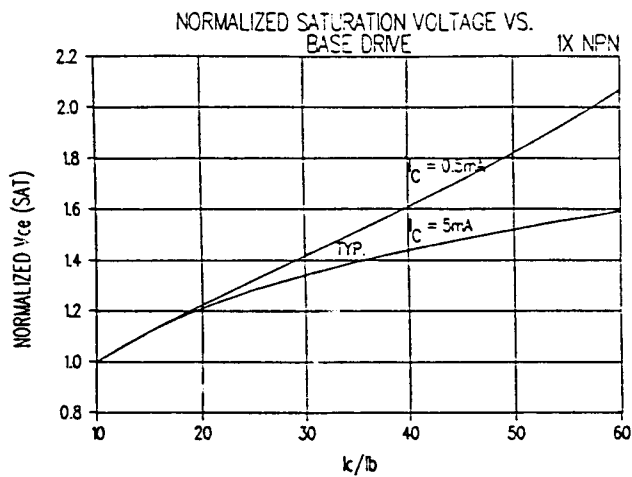
THE MV NPN TRANSISTOR - 1X CONNECTION

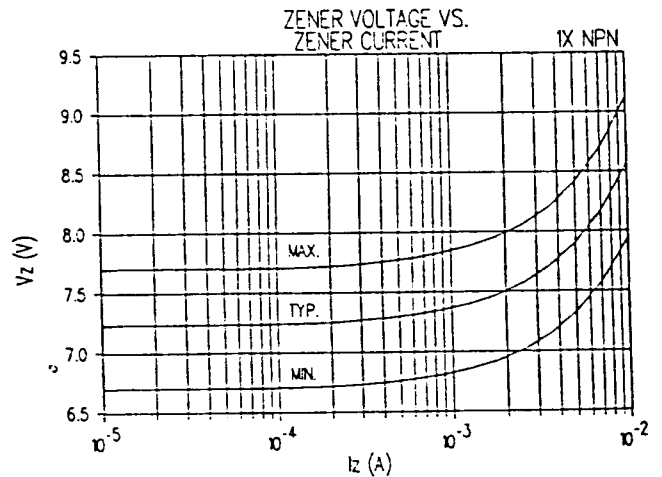
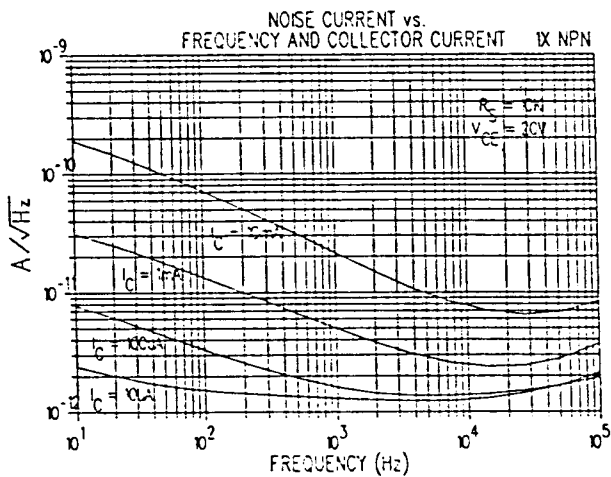
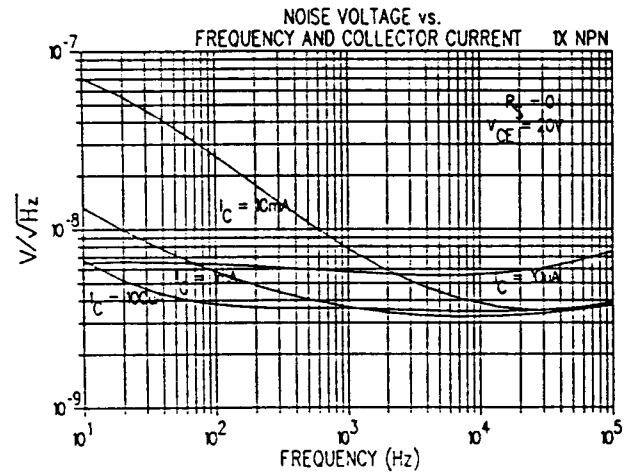
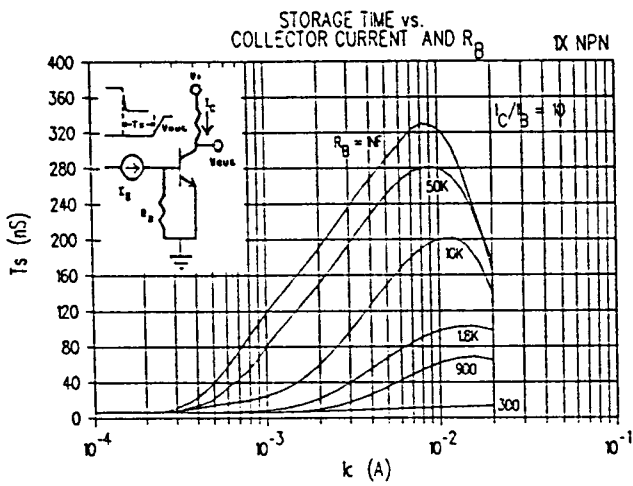
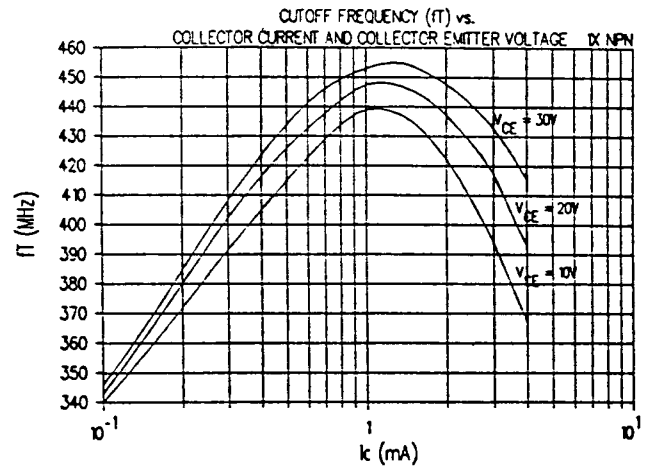
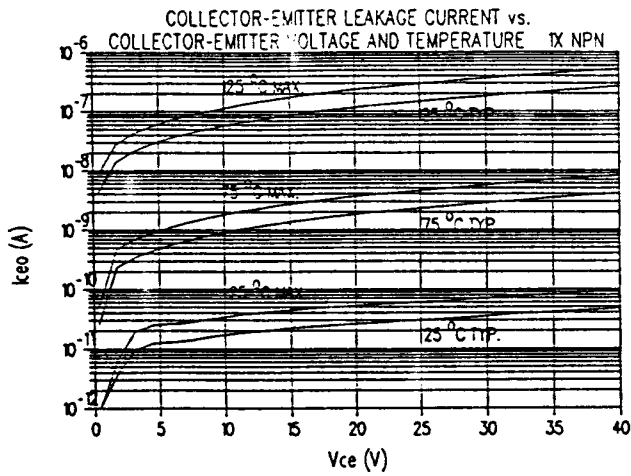
ELECTRICAL CHARACTERISTICS (TA = +25°C) 1X NPN

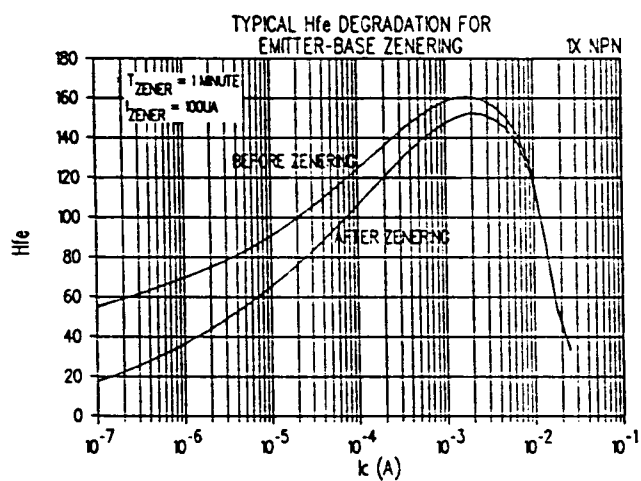
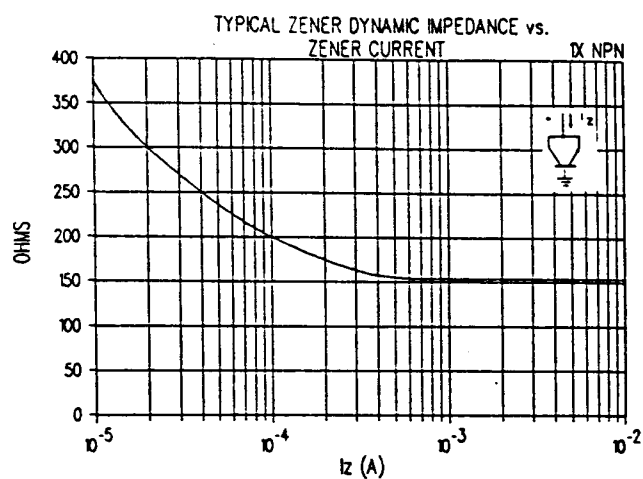
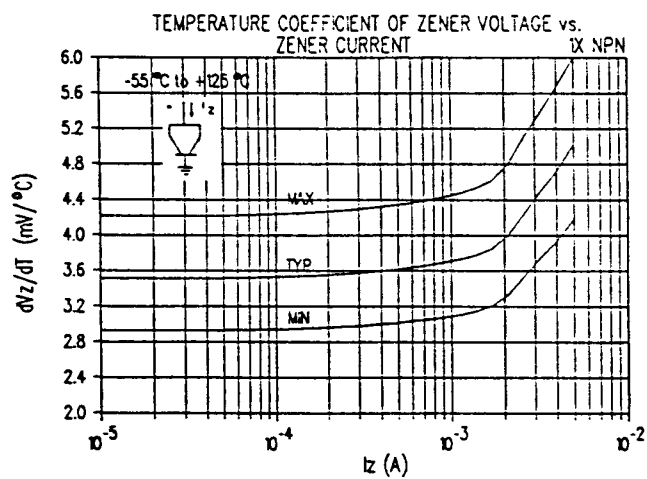
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
Forward Current Gain	βF	VCE=20V, IC=100μA	80		400	
Reverse Current Gain	βR	VCE=-5V, IC=100μA		0.7		
Reverse Saturation Current	IS			3.3x10 ⁻¹⁶		A
Base Emitter Voltage	VBE	VCE=20V, IE=100μA	0.61			V
Collector-Emitter Saturation Voltage	VCE(SAT)	IC=1mA, IB=0.1mA			0.73	V
Emitter-Base Breakdown Voltage	BVEBO	IE=10μA	6.7			V
Collector-Emitter Breakdown Voltage	BVCEO	IC=100μA	40		0.2	V
Collector-Base Breakdown Voltage	BVCBO	IC=100μA	60			V
Collector-Emitter Leakage Current	ICEO	VCE=40V		50	7.7	pA
Collector-Base Leakage Current	ICBO	VCB=40V		5		pA
Emitter-Base Leakage Current	IEBO	VEB=4V		25		pA
Collector Resistance	RC	IC=1mA, IB=2mA		26		Ω
Emitter Resistance	RE	IE=5mA		4		Ω
Base Resistance	RB	IC=10mA		200		Ω
Early Voltage	VA	VCE=20V, IC=100μA		120		V
Current Gain Bandwidth Product	fT	VCE=20V, IC=1mA		450		MHz
Forward Transit Time	TF	VCE=20V, IC=1mA		0.35		nSec
Base Emitter Capacitance	CBEO	VBIAS=0V		0.45		pF
Collector-Base Capacitance	CCBO	VBIAS=0V		0.25		pF
Collector-Substrate Capacitance	CCSO	VBIAS=0V		2		pF





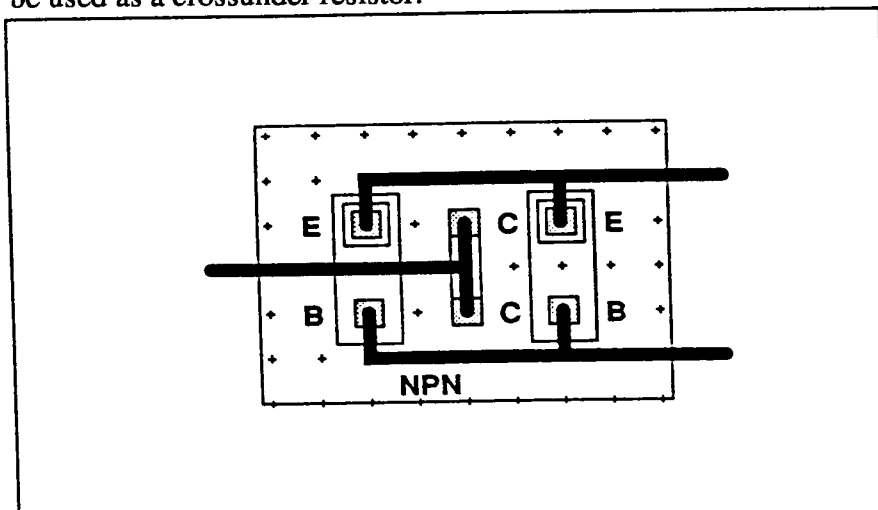






**THE MV 2X NPN
TRANSISTOR
("2X NPN")**

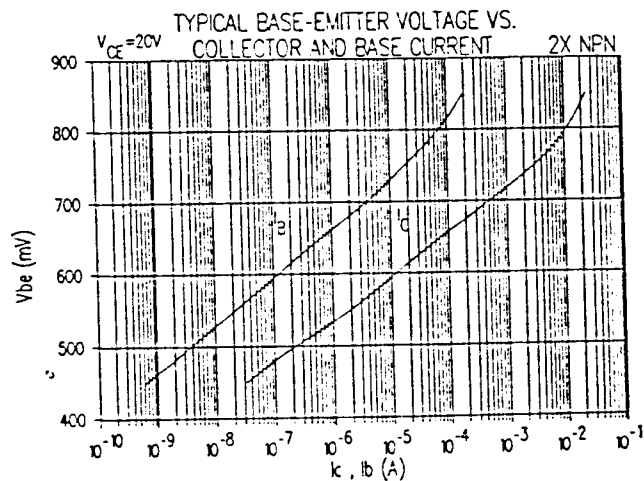
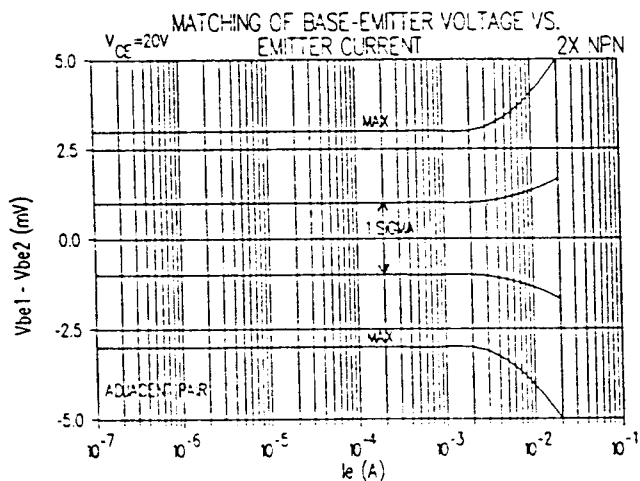
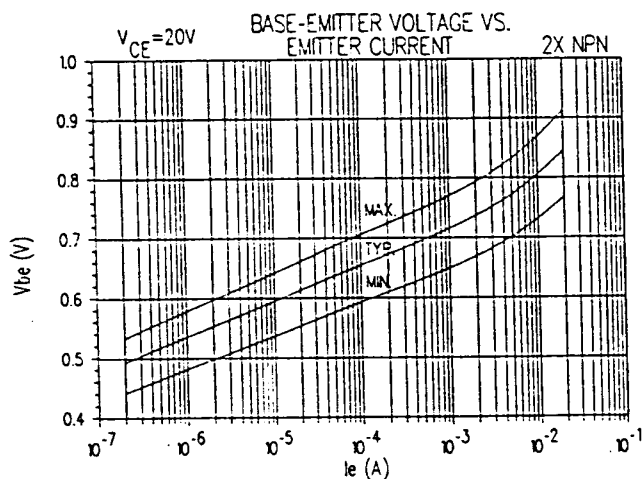
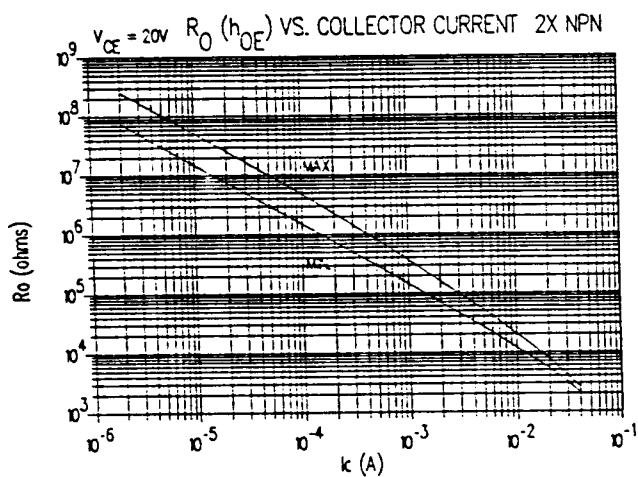
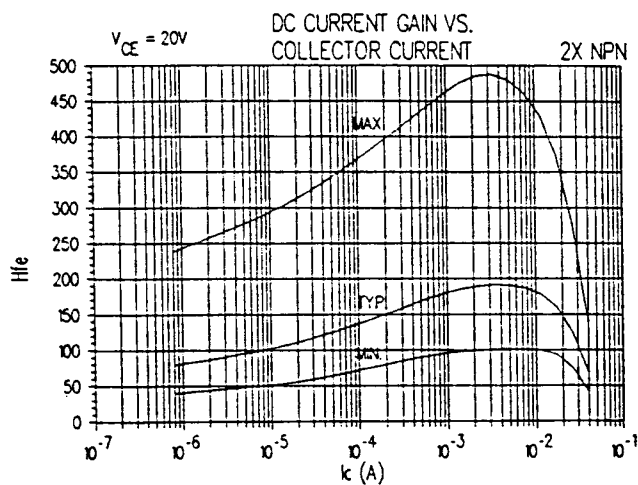
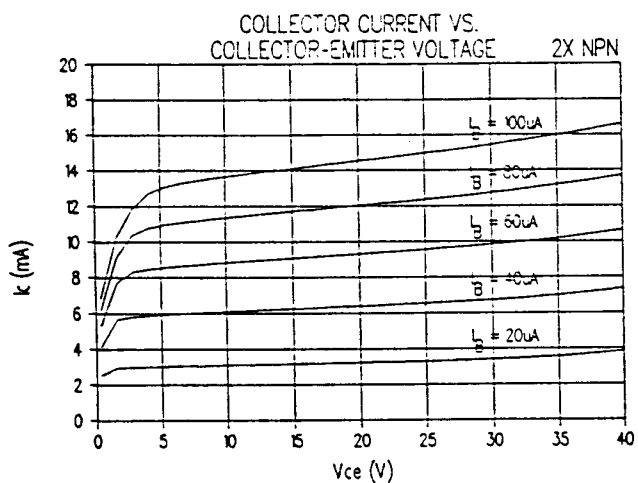
All array cells are common-collector dual NPN transistors as primary gain elements. The independent base and emitter areas allow 2:1 area matching to be achieved as well as providing a more efficient use of the basic silicon area. The double collector contacts allow the low impedance N+ region to be used as a crossunder resistor.

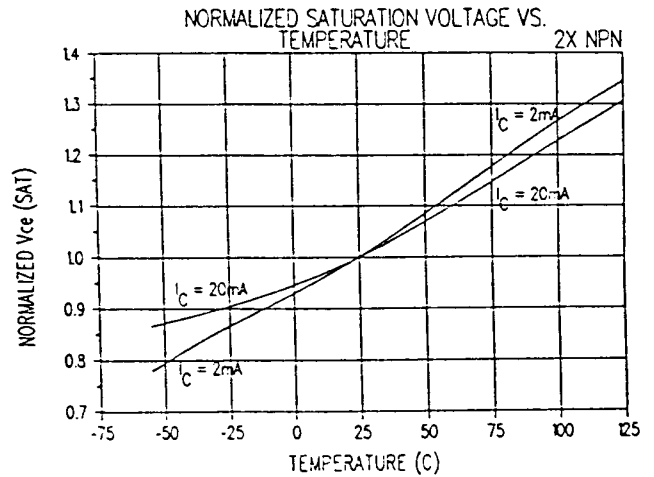
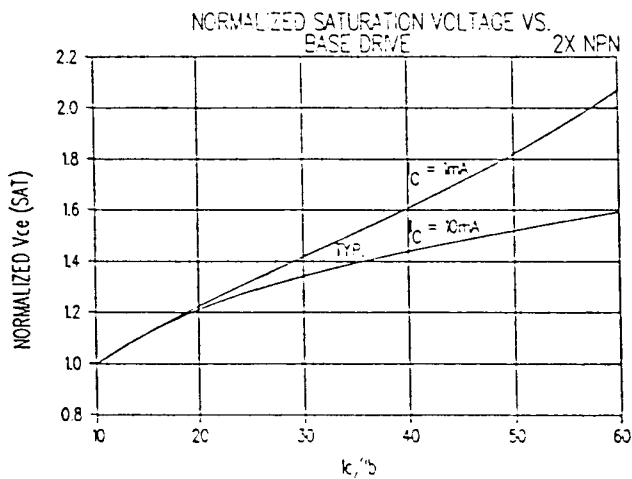
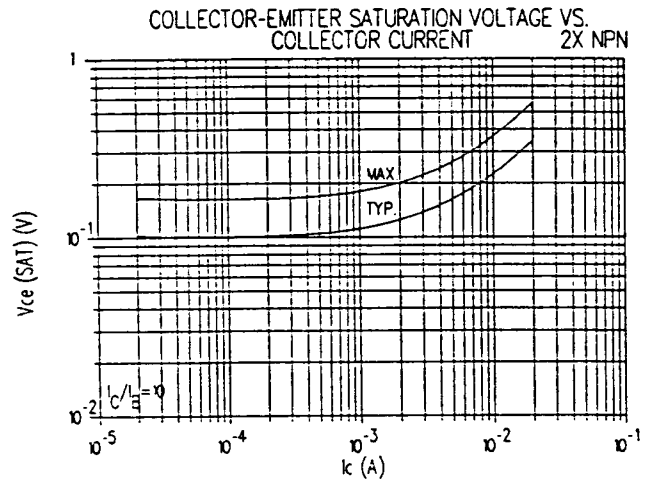
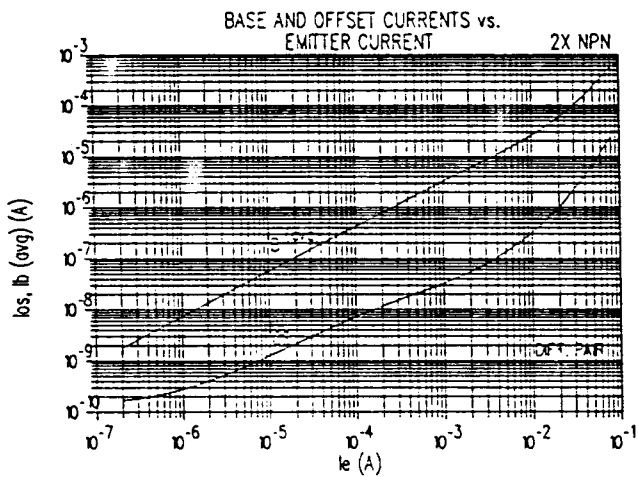
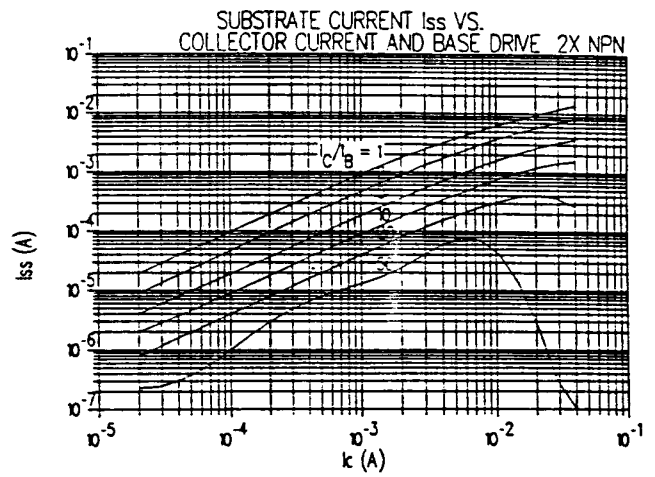
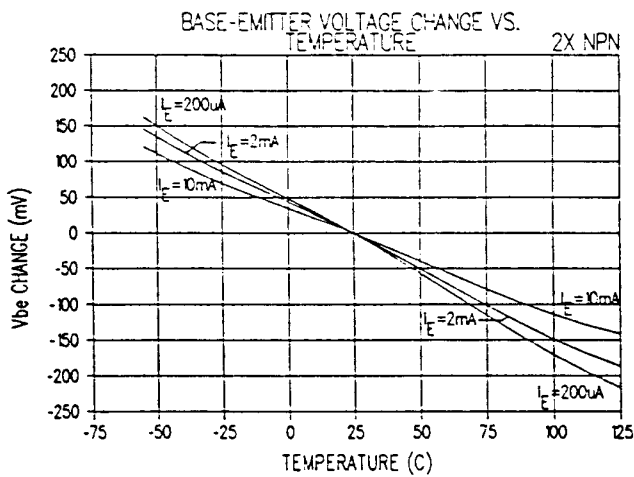


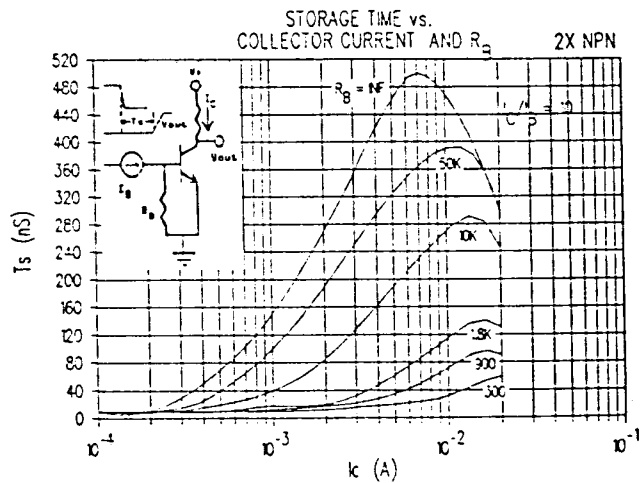
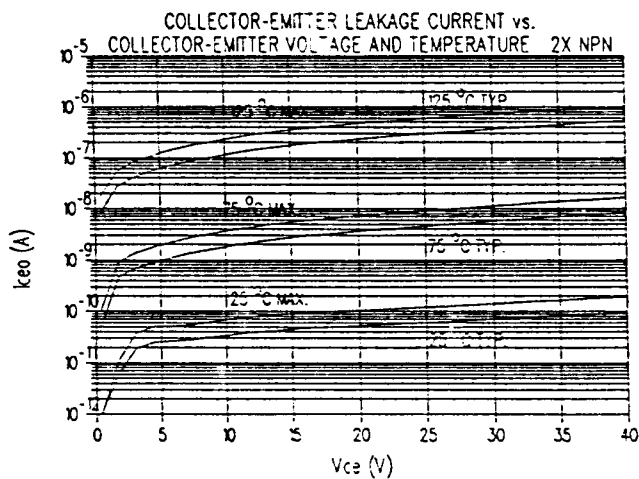
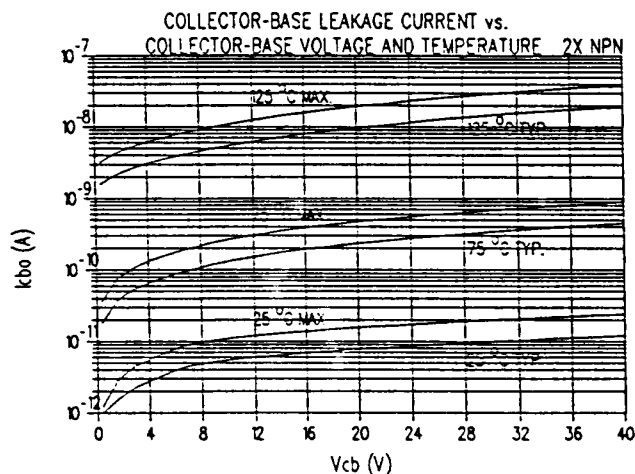
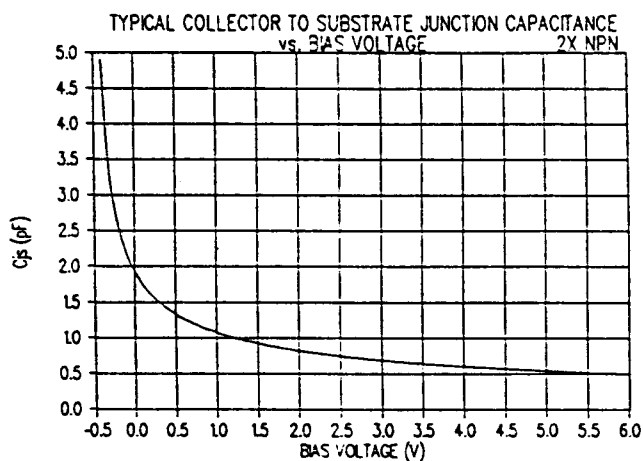
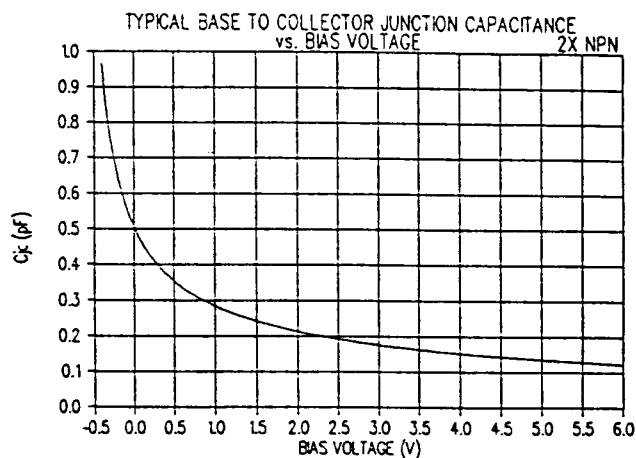
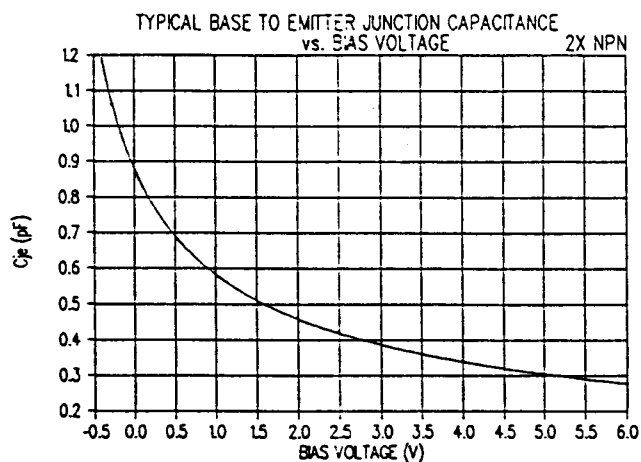
THE MV NPN TRANSISTOR - 2X CONNECTION

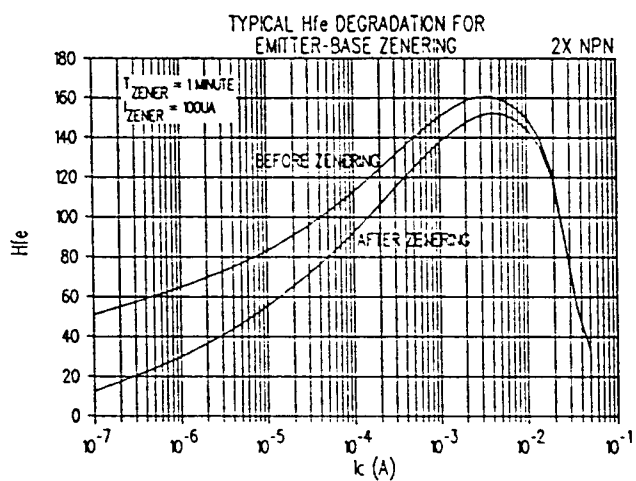
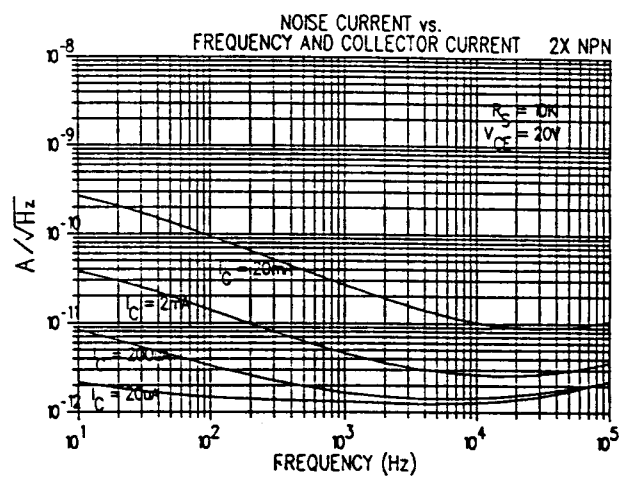
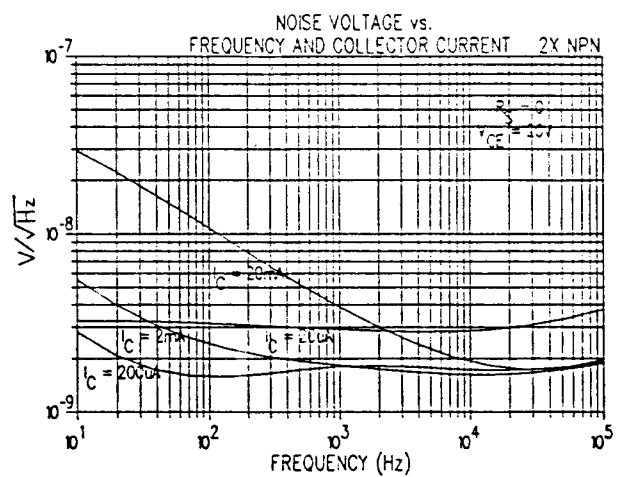
ELECTRICAL CHARACTERISTICS (TA=+25°C) 2X NPN

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
Forward Current Gain	BF	VCE=20V, IC=200μA	80		400	
Reverse Current Gain	BR	VCE=-5V, IC=200μA		0.7		
Reverse Saturation Current	IS			6.6x10 ⁻¹⁶		A
Base Emitter Voltage	VBE	VCE=20V, IE=200μA	0.61			V
Collector-Emitter Saturation Voltage	VCE(SAT)	IC=2mA, IB=0.2mA			0.73	V
Emitter-Base Breakdown Voltage	BVEBO	IE=20μA	6.7			V
Collector-Emitter Breakdown Voltage	BVCEO	IC=200μA	40		0.2	V
Collector-Base Breakdown Voltage	BVCBO	IC=200μA	60		7.7	V
Collector-Emitter Leakage Current	ICEO	VCE=40V		100		pA
Collector-Base Leakage Current	ICBO	VCB=40V		10		pA
Emitter-Base Leakage Current	IEBO	VEB=4V		50		pA
Collector Resistance	RC	IC=2mA, IB=4mA		13		Ω
Emitter Resistance	RE	IE=10mA		2		Ω
Base Resistance	RB	IC=20mA		100		Ω
Early Voltage	VA	VCE=20V, IC=200μA		120		V
Current Gain Bandwidth Product	fT	VCE=20V, IC=2mA		450		MHz
Forward Transit Time	TF	VCE=20V, IC=2mA		0.35		nSec
Base Emitter Capacitance	CBEO	VBIAS=0V		0.45		pF
Collector-Base Capacitance	CCBO	VBIAS=0V		0.25		pF
Collector-Substrate Capacitance	CCSO	VBIAS=0V		2		pF



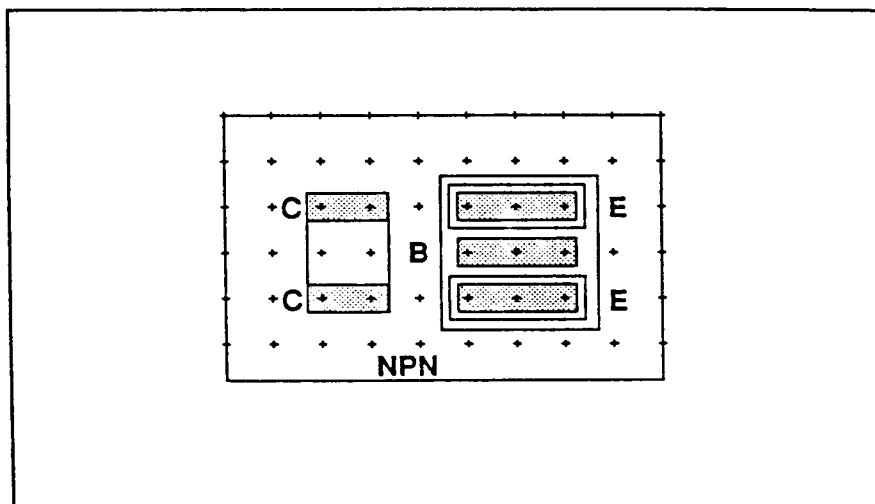






**THE MV MEDIUM
NPN TRANSISTOR
("MD NPN")**

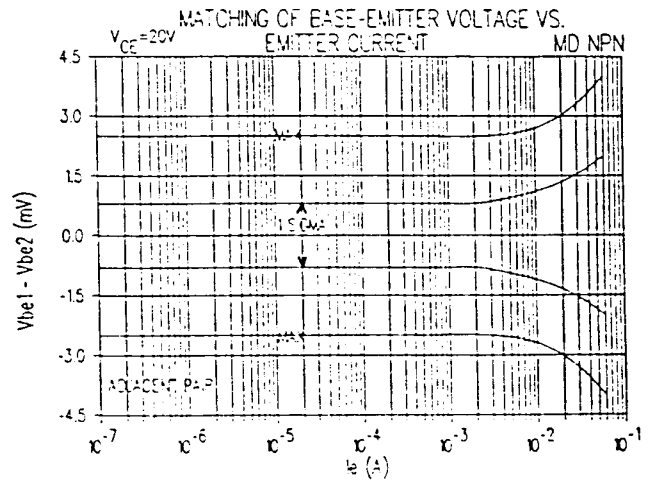
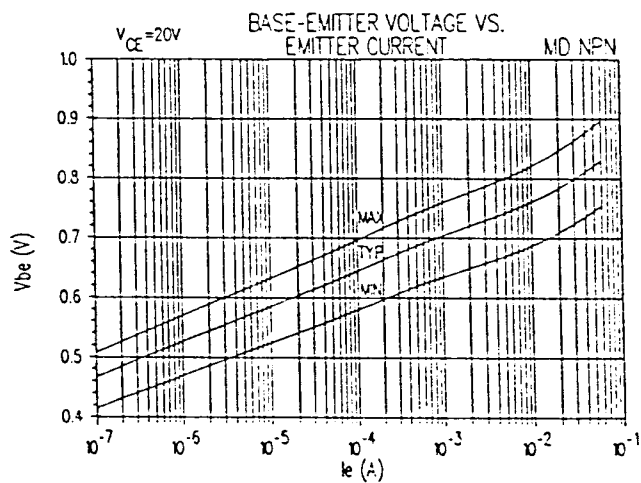
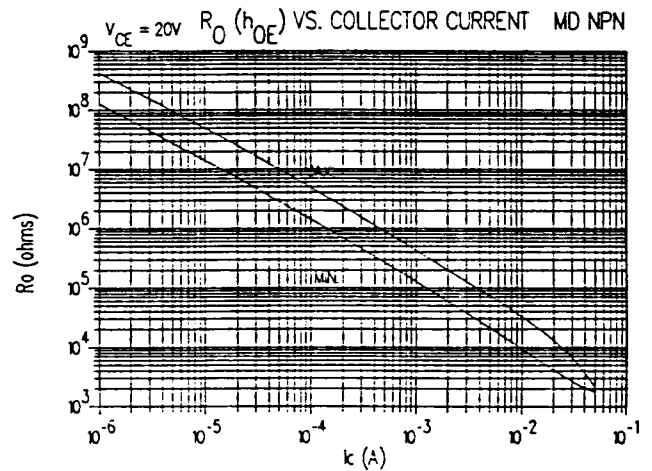
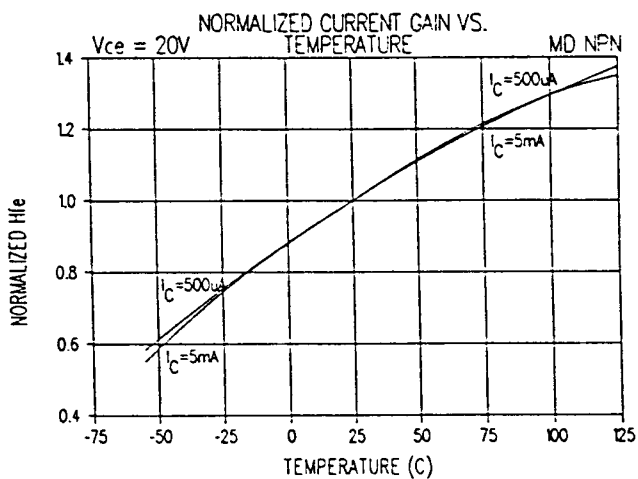
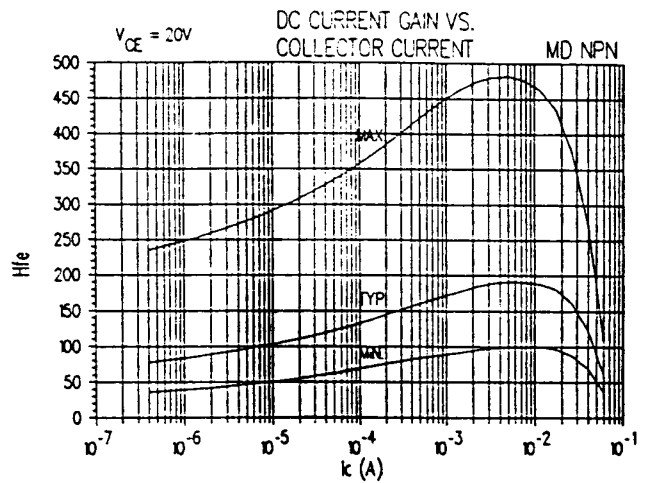
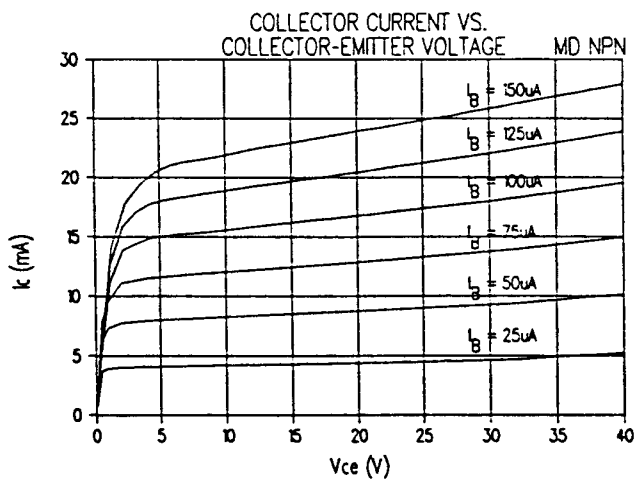
The medium NPN transistor is a peripheral component with lengthened rectangle emitters to provide increased current capability. The double collector contacts allow the low impedance N+ region to be used as a crossunder resistor.

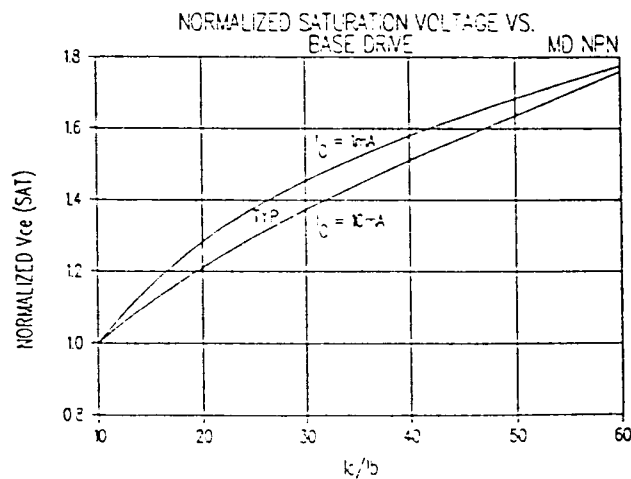
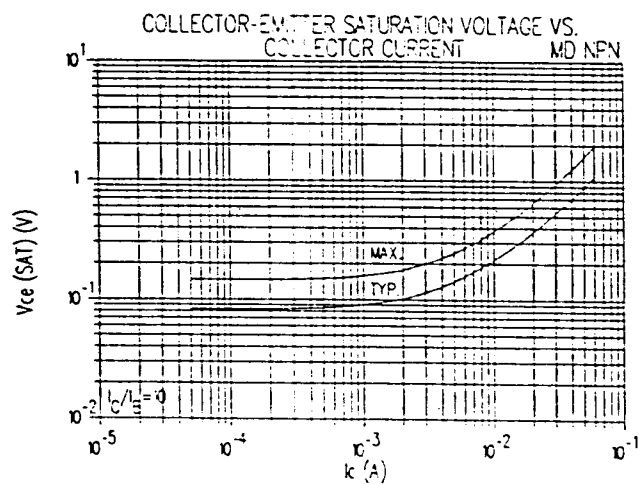
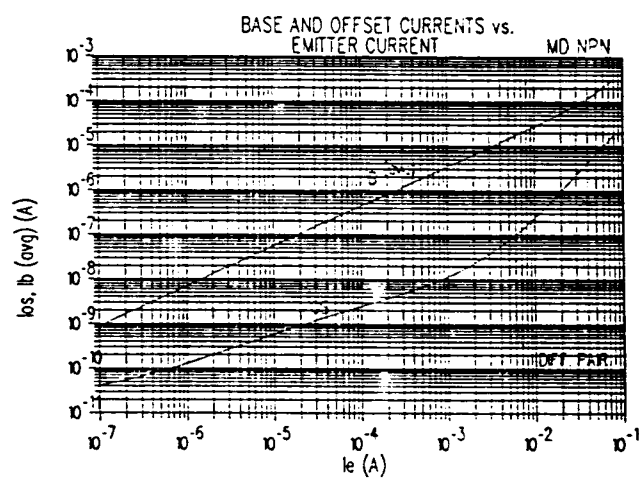
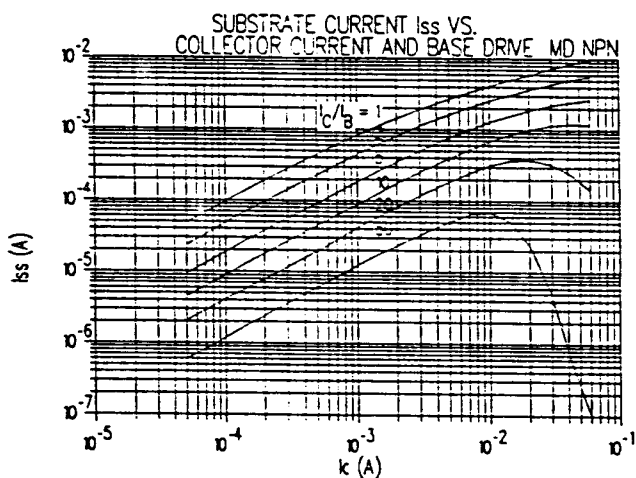
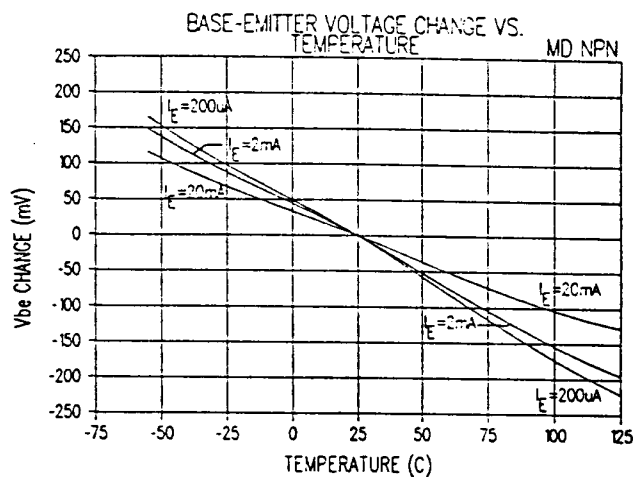


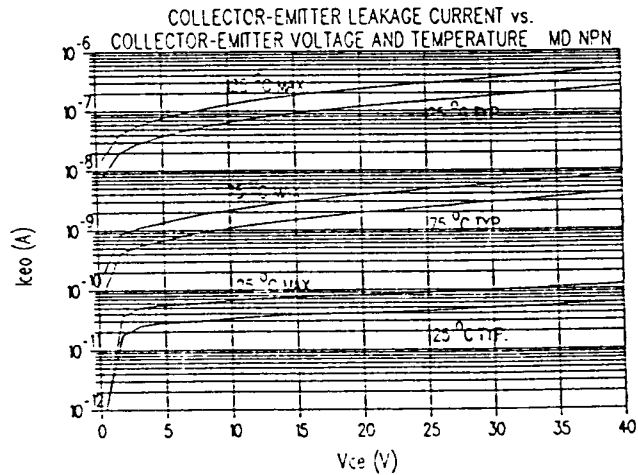
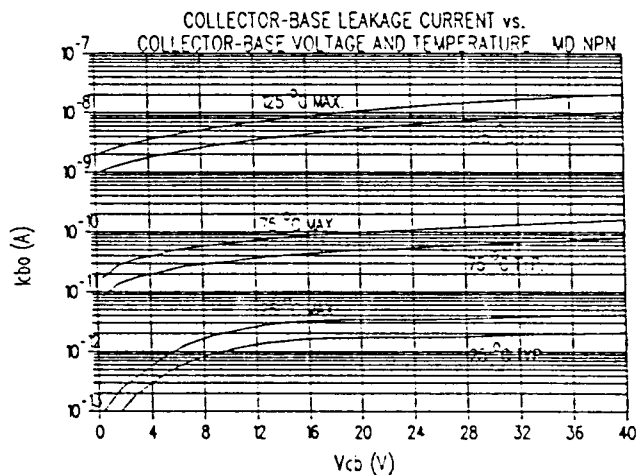
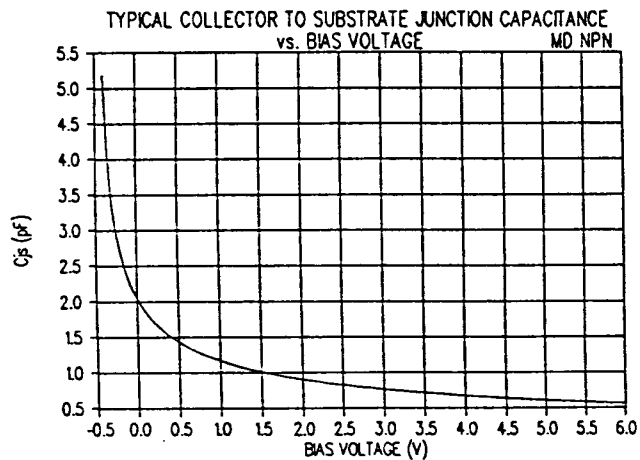
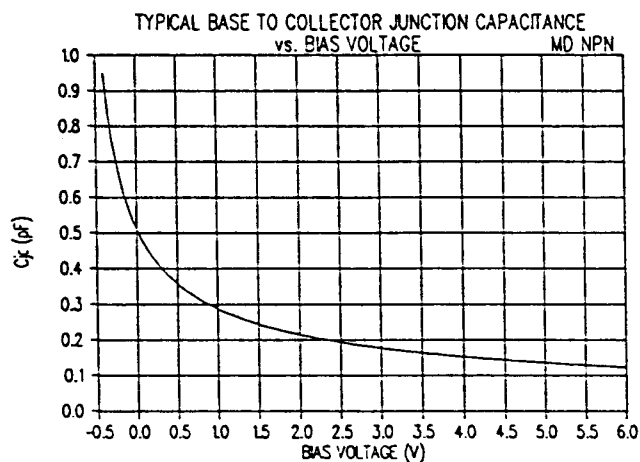
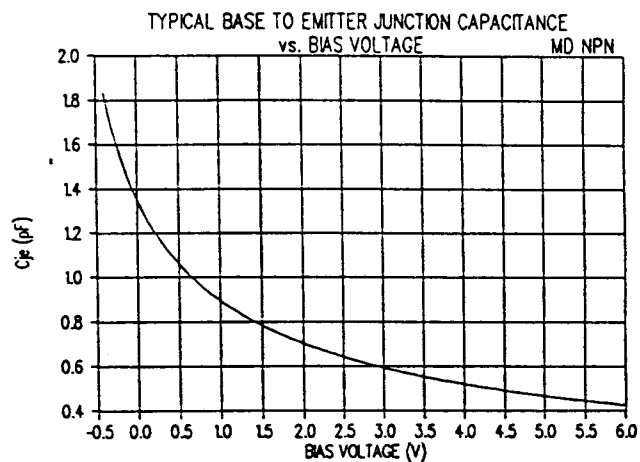
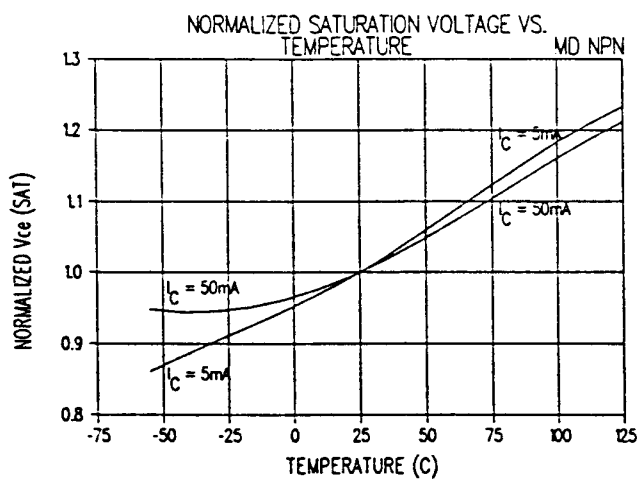
THE MV MEDIUM NPN TRANSISTOR - ("MD NPN")

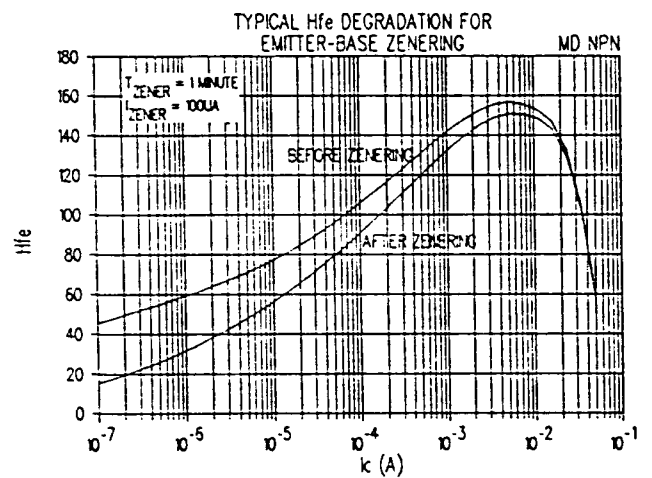
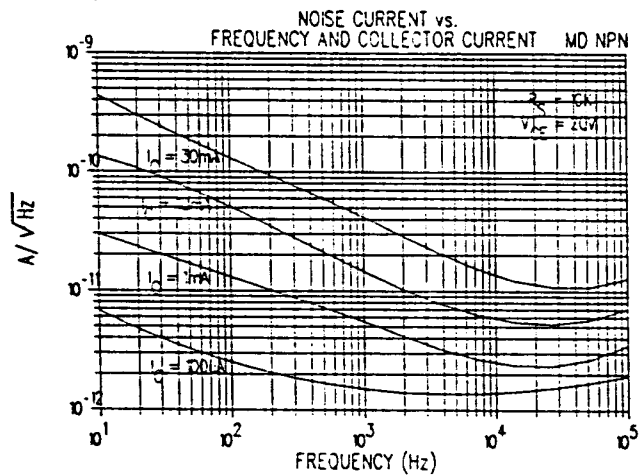
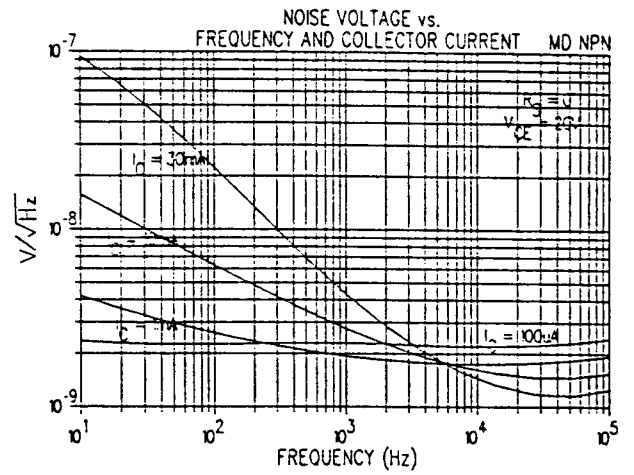
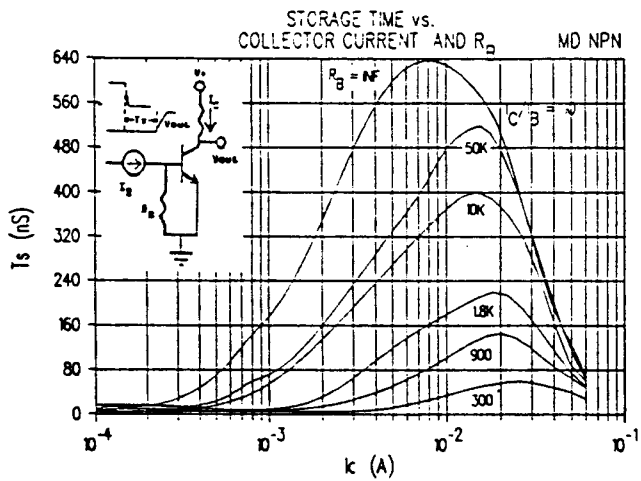
ELECTRICAL CHARACTERISTICS (T_A = +25°C) MEDIUM NPN

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
Forward Current Gain	βF	VCE=20V, IC=300μA	80		400	
Reverse Current Gain	βR	VCE=-5V, IC=-300μA		2.8		
Reverse Saturation Current	IS			1.0x10 ⁻¹⁵		A
Base Emitter Voltage	VBE	VCE=20V, IE=300μA	0.61			V
Collector-Emitter Saturation Voltage	VCE(SAT)	IC=3mA, IB=300μA			0.73	V
Emitter-Base Breakdown Voltage	BVEBO	IE=30μA	6.7			V
Collector-Emitter Breakdown Voltage	BVCEO	IC=300μA	40		0.2	V
Collector-Base Breakdown Voltage	BVCBO	IC=300μA	60		7.7	V
Collector-Emitter Leakage Current	ICEO	VCE=40V		60		pA
Collector-Base Leakage Current	ICBO	VCB=40V		2		pA
Emitter-Base Leakage Current	IEBO	VEB=4V		30		pA
Collector Resistance	RC	IC=3mA, IB=6mA		12		Ω
Emitter Resistance	RE	IE=15mA		1		Ω
Base Resistance	RB	IC=30mA		30		Ω
Early Voltage	VA	VCE=20V, IC=300μA		125		V
Current Gain Bandwidth Product	fT	VCE=20V, IC=3mA		450		MHz
Forward Transit Time	TF	VCE=20V, IC=3mA		0.31		nSec
Base Emitter Capacitance	CBEO	VBIAS=0V		1.35		pF
Collector-Base Capacitance	CCBO	VBIAS=0V		0.5		pF
Collector-Substrate Capacitance	CCSO	VBIAS=0V		2		pF



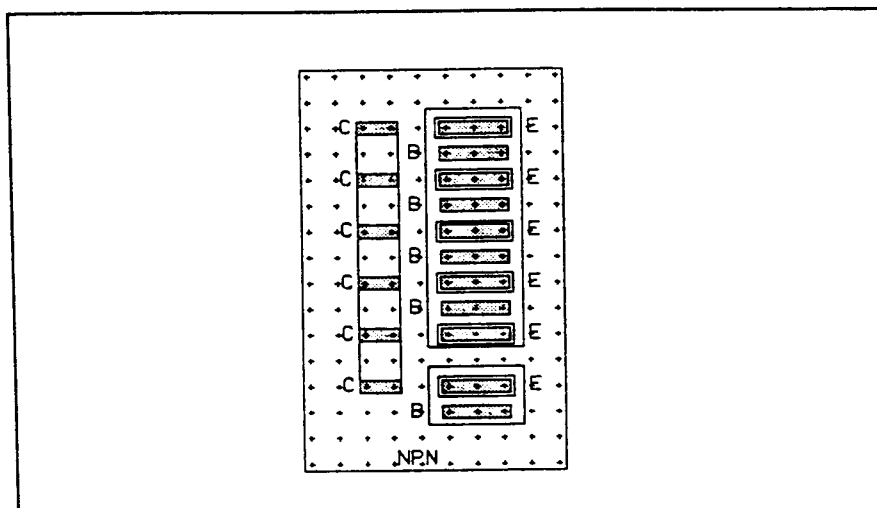






**THE MV LARGE NPN
TRANSISTOR
("LG NPN")**

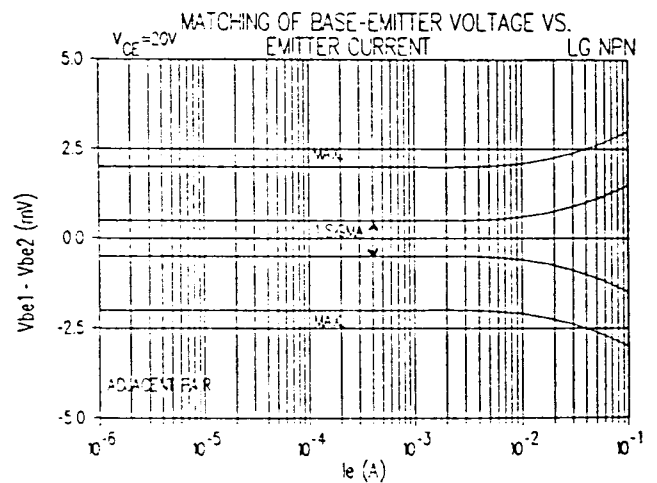
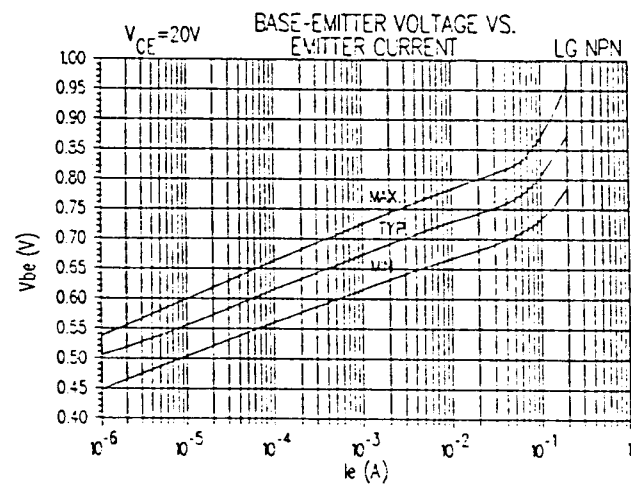
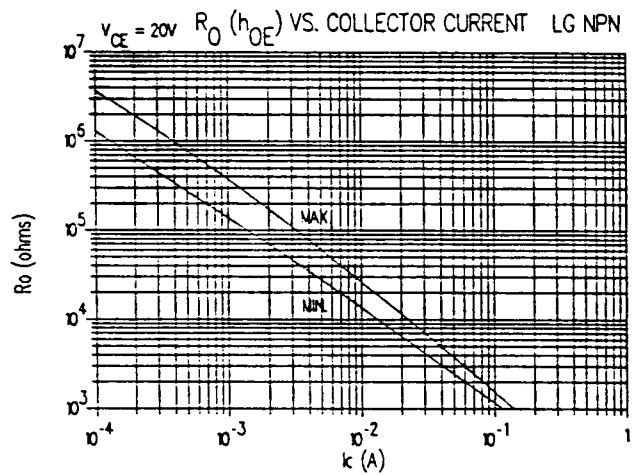
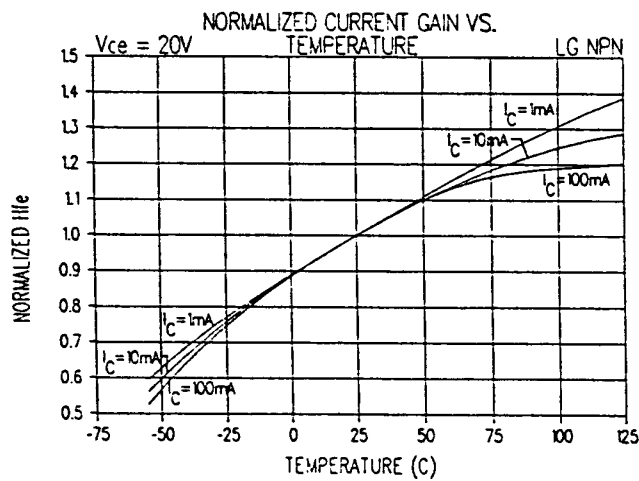
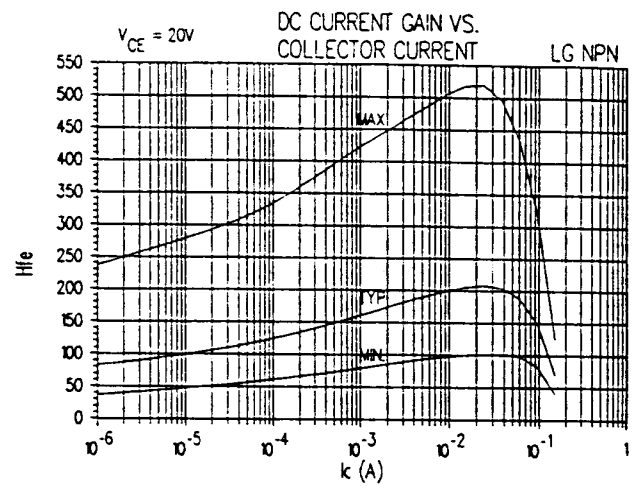
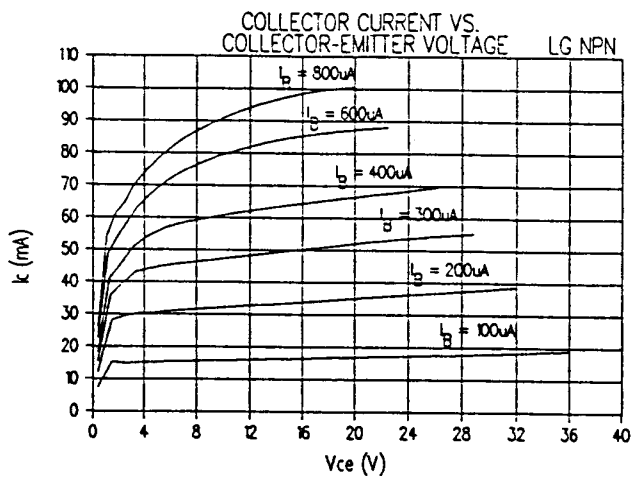
The large NPN transistor is a peripheral component with additional long rectangular emitters designed to provide high current capability. This is a common-collector dual NPN transistor with a 5:1 emitter area ratio. The six collector contacts allow the low impedance N+ region to be used as a crossunder resistor.

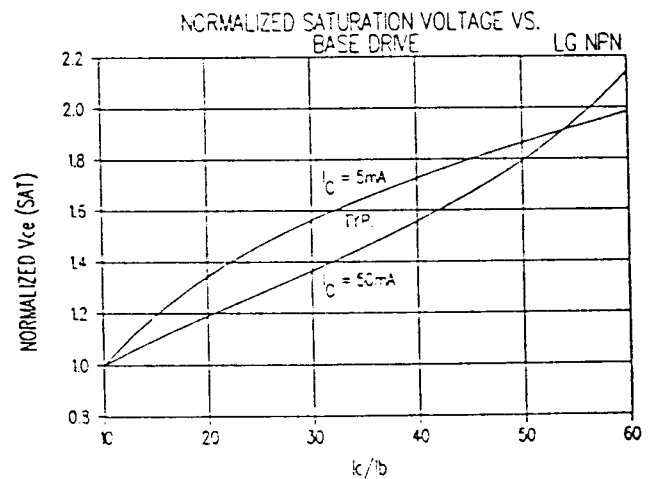
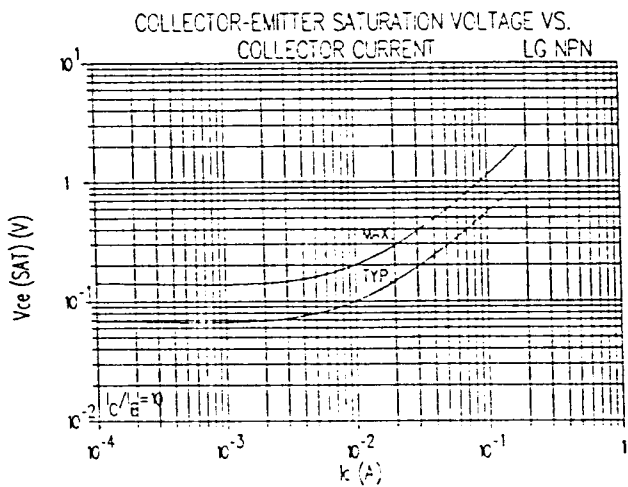
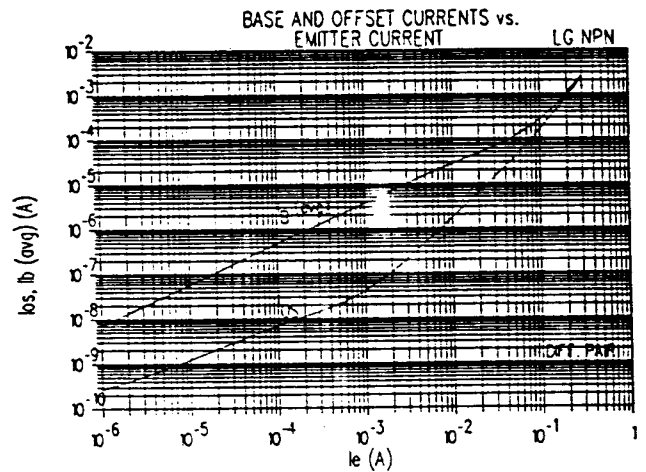
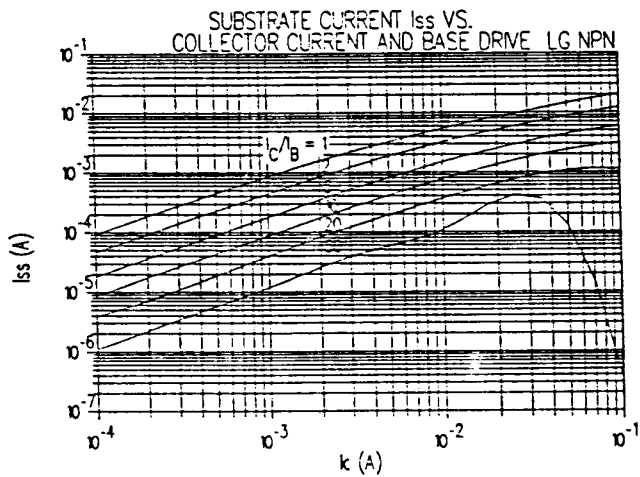
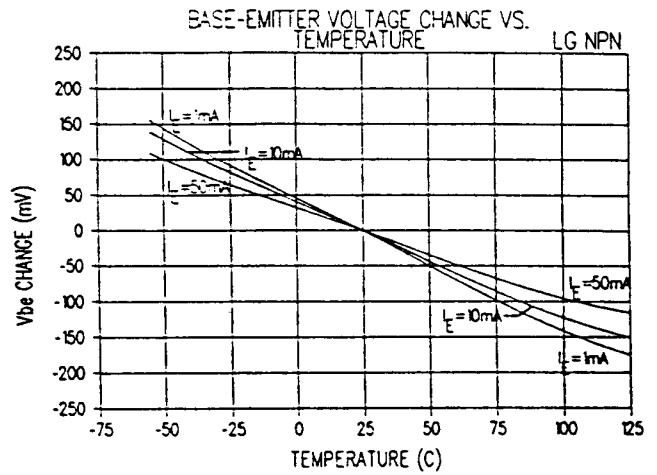
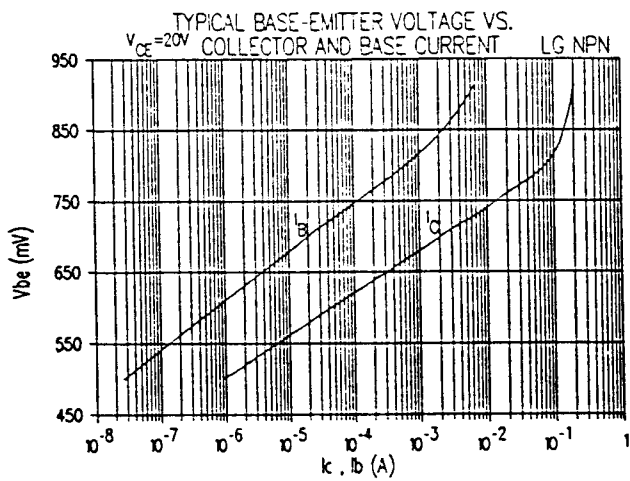


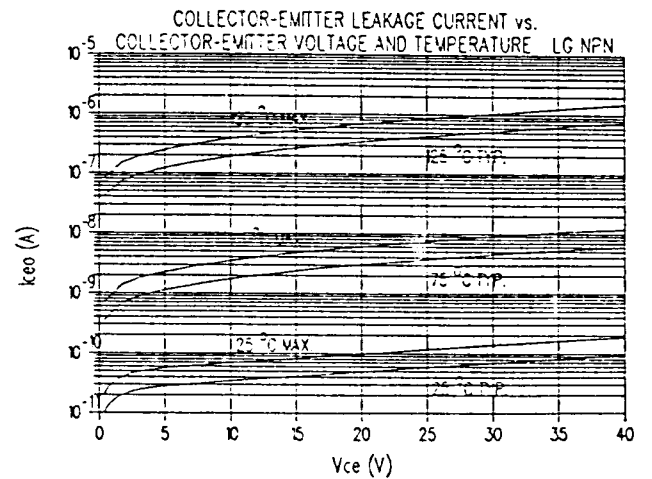
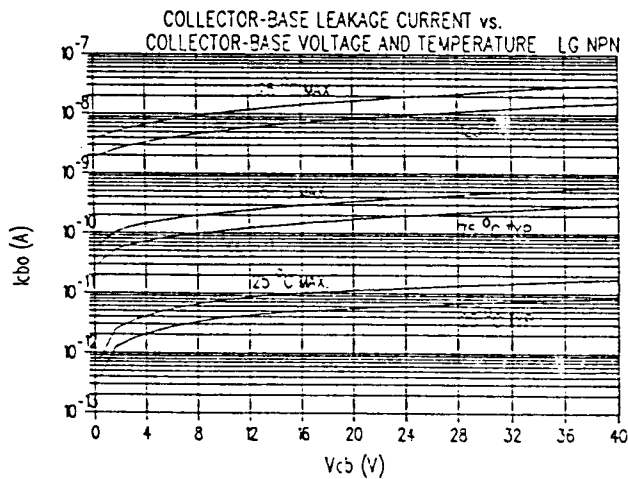
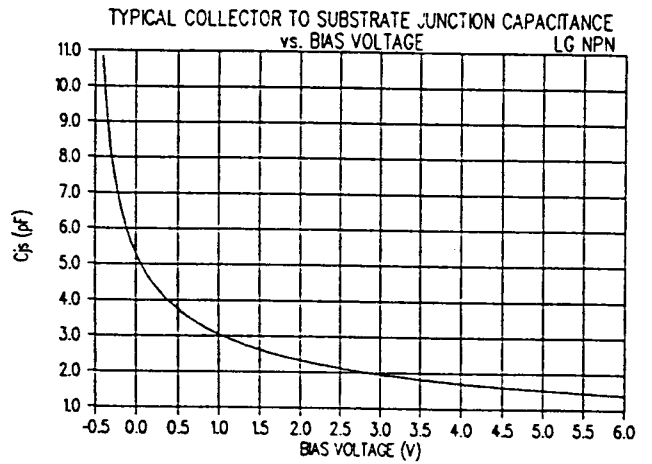
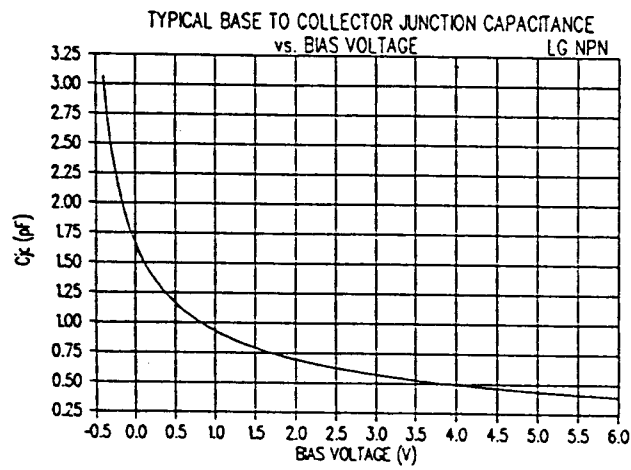
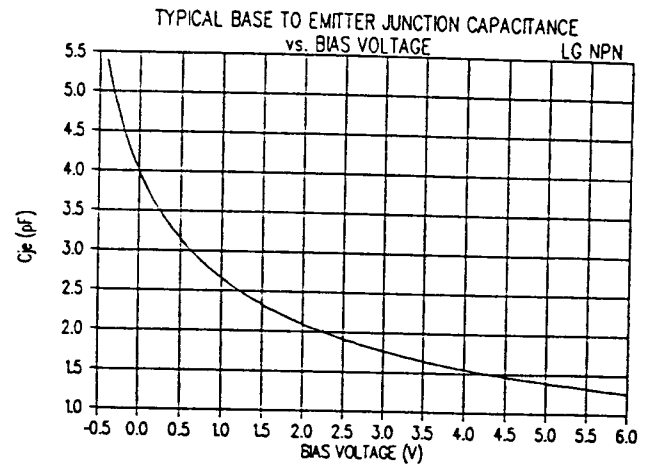
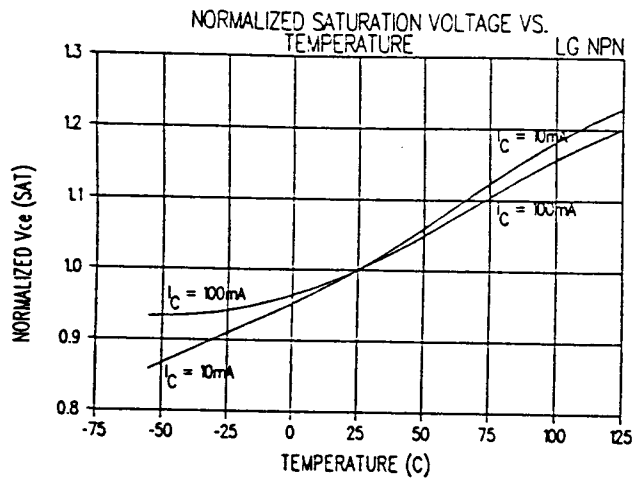
THE MV LARGE NPN TRANSISTOR - ("LG NPN")

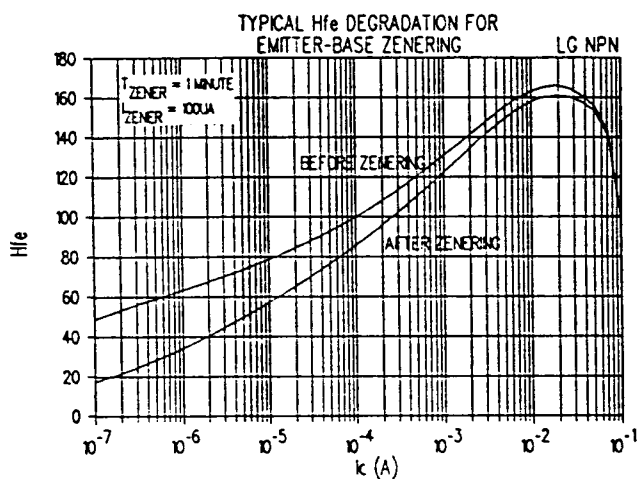
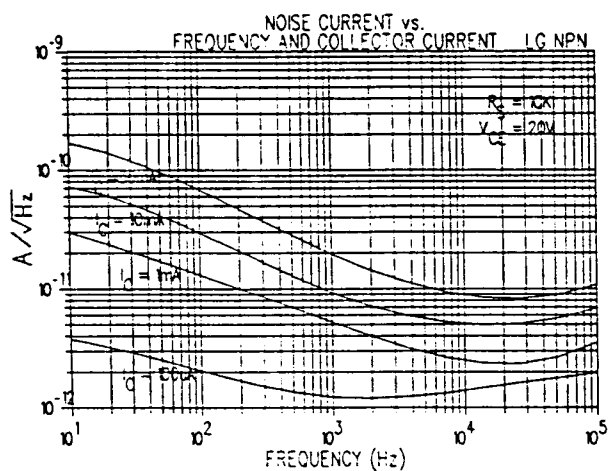
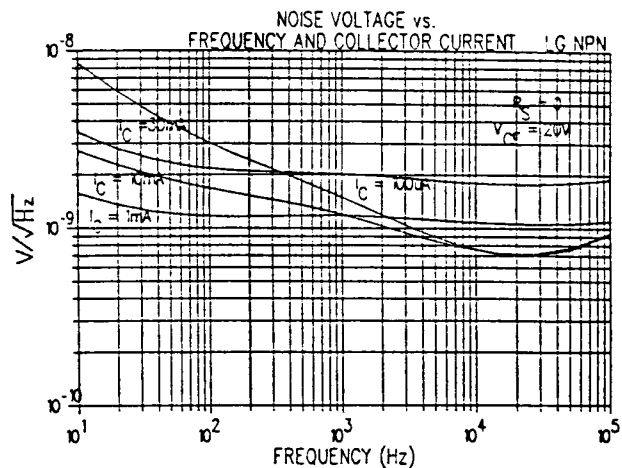
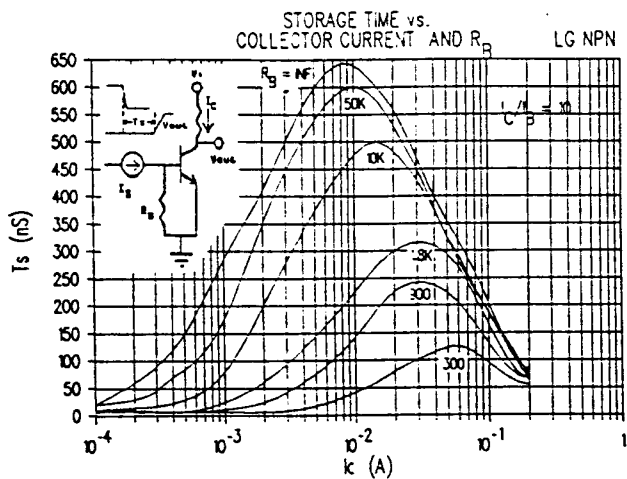
ELECTRICAL CHARACTERISTICS (TA = +25°C) LARGE NPN

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
Forward Current Gain	βF	VCE=20V, IC=1mA	80		425	
Reverse Current Gain	βR	VCE=-5V, IC=-1mA		4		
Reverse Saturation Current	IS			2.9x10 ⁻¹⁵		A
Base Emitter Voltage	VBE	VCE=20V, IE=1mA	0.61			V
Collector-Emitter Saturation Voltage	VCE(SAT)	IC=10mA, IB=1mA			0.73	V
Emitter-Base Breakdown Voltage	BVEBO	IE=100μA	6.7			V
Collector-Emitter Breakdown Voltage	BVCEO	IC=1mA	40		0.2	V
Collector-Base Breakdown Voltage	BVCBO	IC=1mA	60		7.7	V
Collector-Emitter Leakage Current	ICEO	VCE=40V		100		pA
Collector-Base Leakage Current	ICBO	VCB=40V		10		pA
Emitter-Base Leakage Current	IEBO	VEB=4V		50		pA
Collector Resistance	RC	IC=10mA, IB=20mA		4		Ω
Emitter Resistance	RE	IE=50mA		0.3		Ω
Base Resistance	RB	IC=100mA		10		Ω
Early Voltage	VA	VCE=20V, IC=1mA		133		V
Current Gain Bandwidth Product	fT	VCE=20V, IC=10mA		450		MHz
Forward Transit Time	TF	VCE=20V, IC=10mA		0.3		nSec
Base Emitter Capacitance	CBE0	VBIAS=0V		4		pF
Collector-Base Capacitance	CCBO	VBIAS=0V		1.7		pF
Collector-Substrate Capacitance	CCSO	VBIAS=0V		5.3		pF



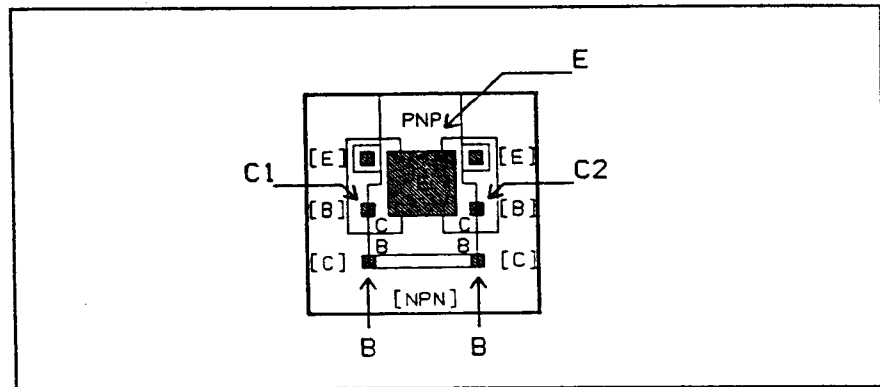






THE MV MONISTOR (PNP/NPN)

For increased versatility, each array cell contains monistors instead of dedicated lateral PNP transistors. The monistor is a multi-purpose device which may be connected to function as either a lateral PNP transistor or an NPN transistor. When connected as a lateral PNP transistor, the monistor has two collectors. The two base contacts allow the low impedance N+ region to be used as a crossunder resistor. When connected as an NPN transistor, the monistor is a common-collector dual NPN transistor with emitter areas equal to those of the dedicated small NPN transistor. The dual collector contacts allow the low impedance N+ region to be used as a crossunder resistor. For design data on NPN operation, see the 2X NPN design data.



THE MV MONISTOR - LATERAL PNP CONNECTION ("MN PNP")

USING THE MONISTOR AS A LATERAL PNP TRANSISTOR ("MN PNP")

When using the Monistor as a lateral PNP transistor, connect it as shown here. The monistor will behave as a lateral PNP transistor, with all of the advantages and disadvantages associated with any lateral PNP transistor.

The lateral PNP transistor is a compromise device designed in such a way as not to add any processing steps. Although this results in a low gain and frequency response, the lateral PNP transistor is nevertheless a highly useful device.

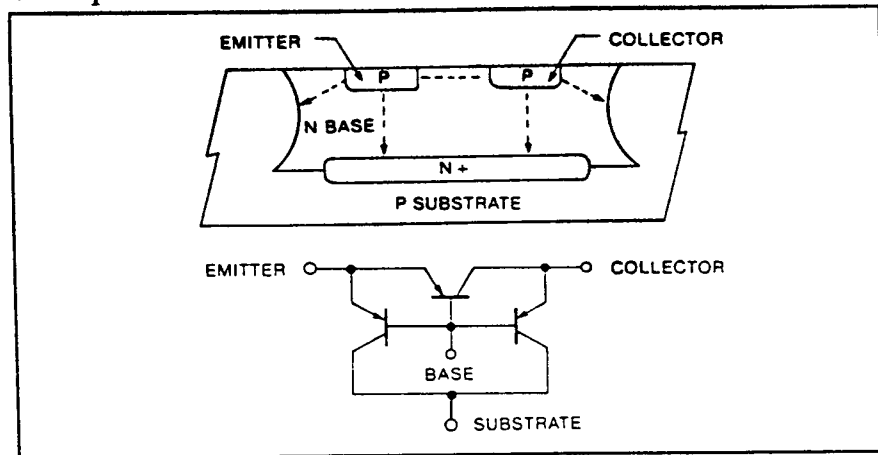
This structure utilizes the NPN transistor base diffusion to form concentric emitter and collector regions. The epitaxial region acts as the base. Thus the current flows laterally, along the surface, between emitter and collector. The PNP transistors have two collectors which can be used as two independent transistors, with base and emitter tied together. Both collectors must be used. They may be tied together, or an unused collector may be tied to the substrate or any place in the circuit where the transistor will not saturate. If one collector is left open or allowed to saturate, the apparent beta of the other transistor will drop by as much as a factor of five and it will conduct 70% of the emitter current. The currents in the two collectors will be substantially equal for equal collector voltages (matched with $\pm 1\%$). Variation of collector due to Early Effect and due to electrical crossfields will cause additional mismatch if the collector voltages are not equal.

There are two stray effects which must be kept in mind when using any lateral PNP transistor. Both are created by the fact that in addition to the

PNP structure near the surface, there is also a second PNP transistor formed by the emitter and base of the lateral device and the substrate acting as collector.

When the lateral PNP transistor is in its normal active region (not saturated), the substrate collector received only a small fraction of the lateral collector current. Thus, unless your application requires high precision, this fraction of the collector current lost to the substrate can generally be ignored.

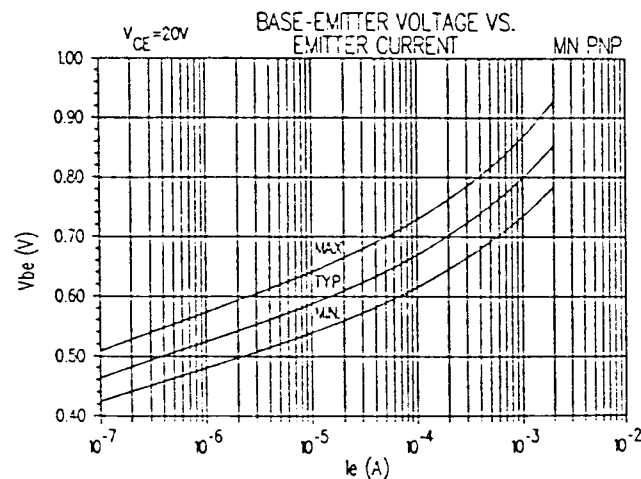
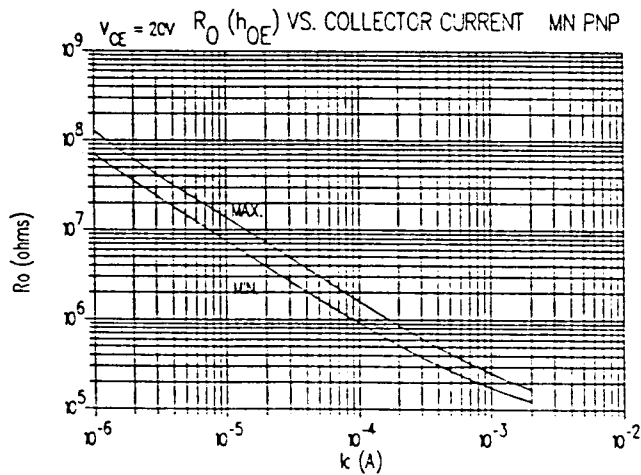
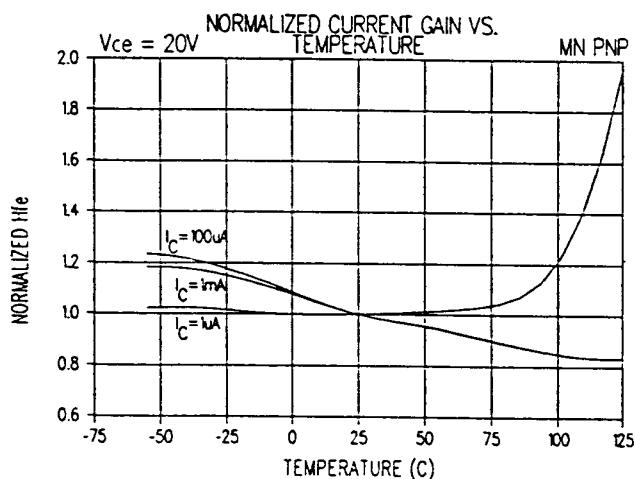
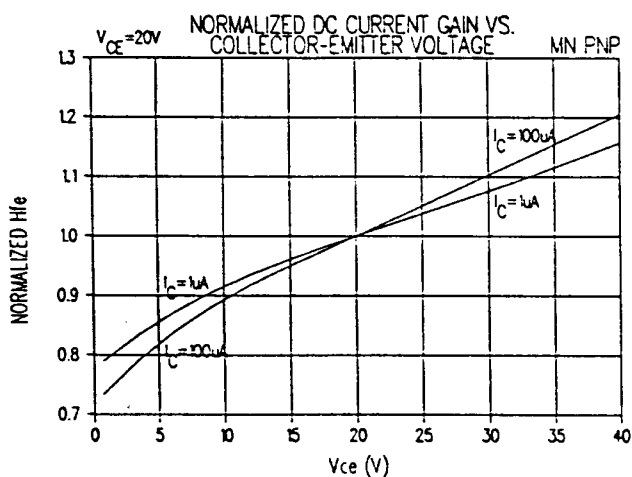
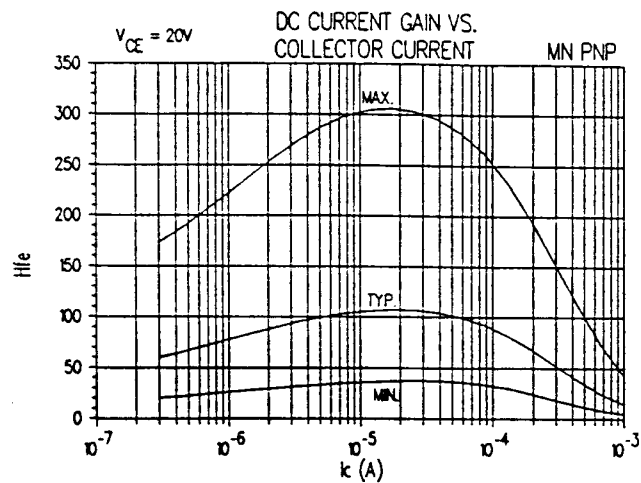
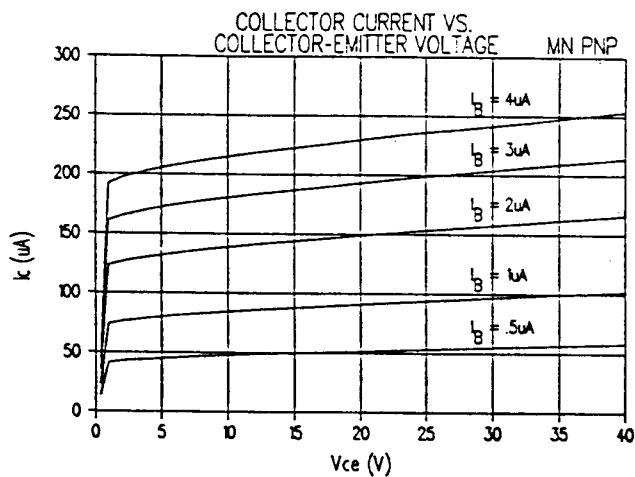
The second stray effect, however, can be more serious. If a lateral PNP transistor is allowed to saturate, the substrate PNP transistor becomes heavily active. The substrate current can be figured from the graph of substrate current versus collector current. Too much substrate current can cause problems.

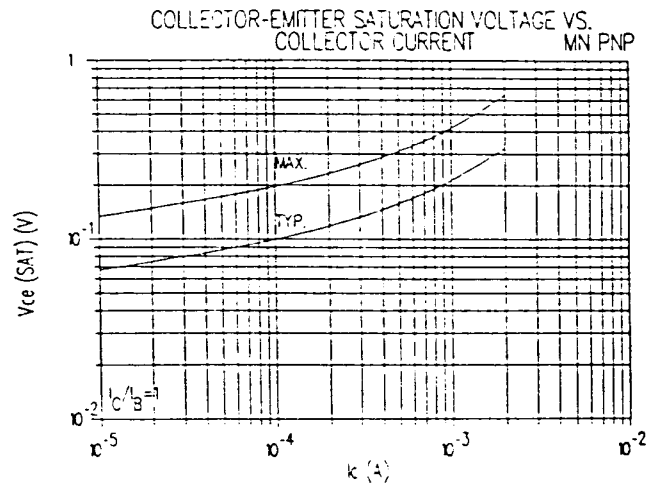
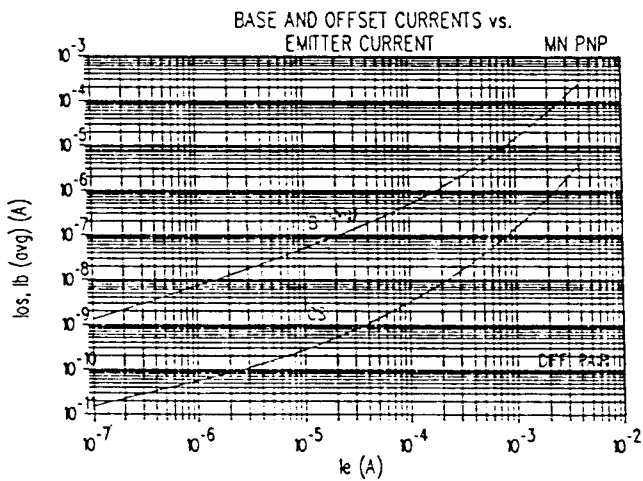
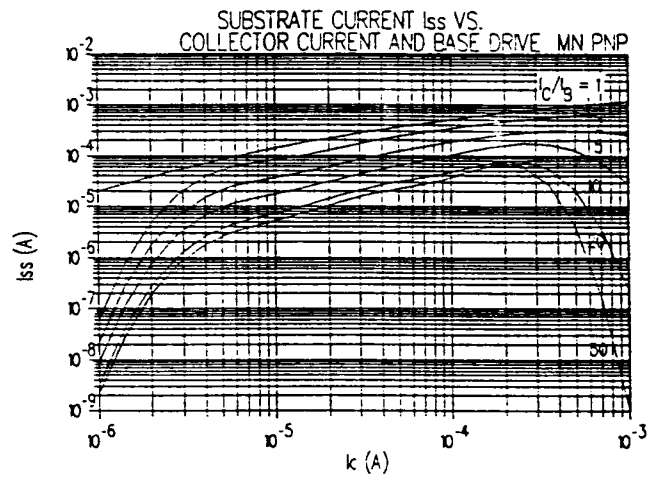
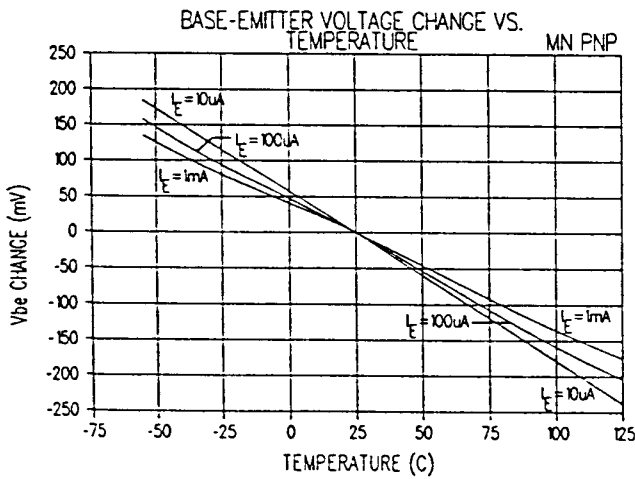
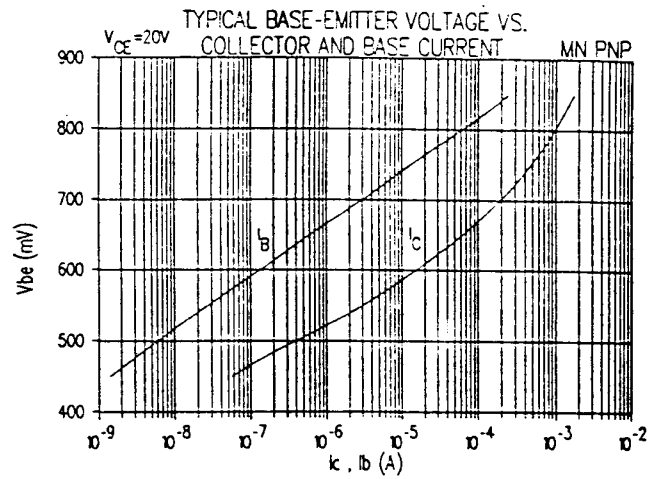
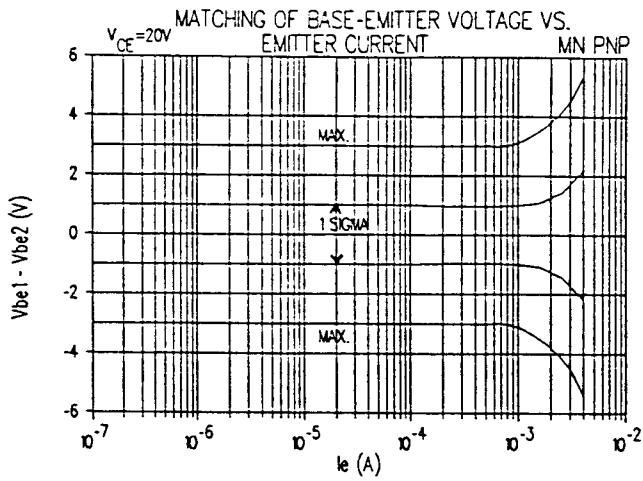


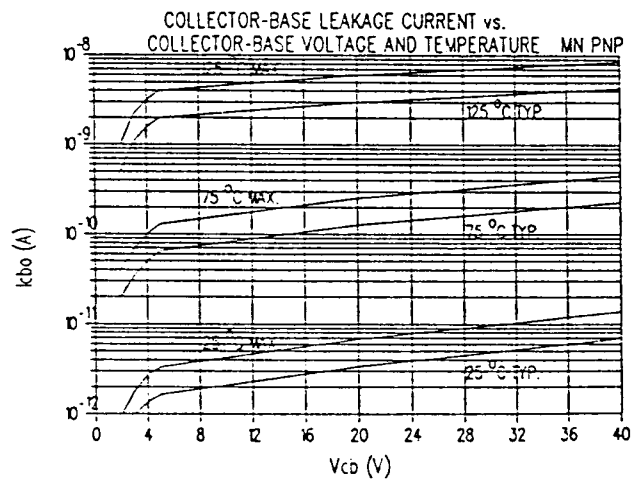
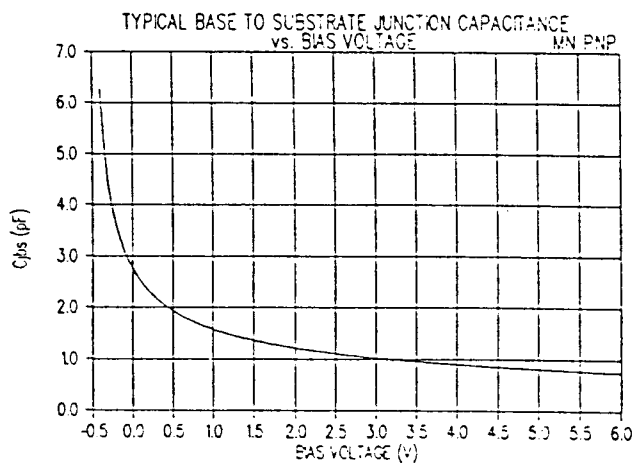
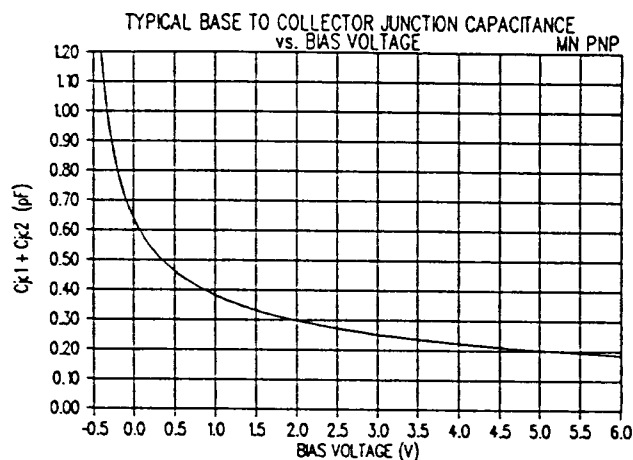
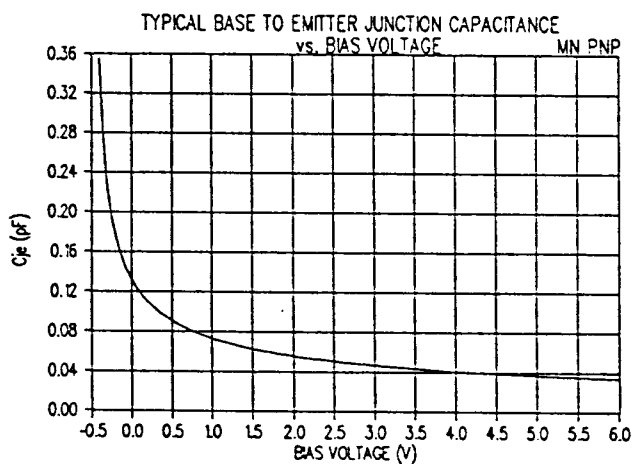
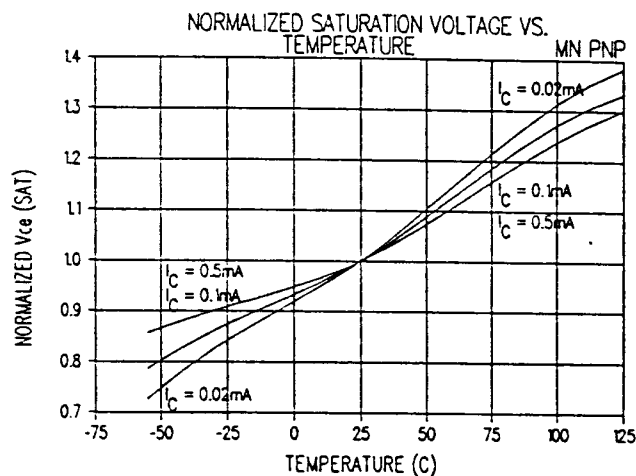
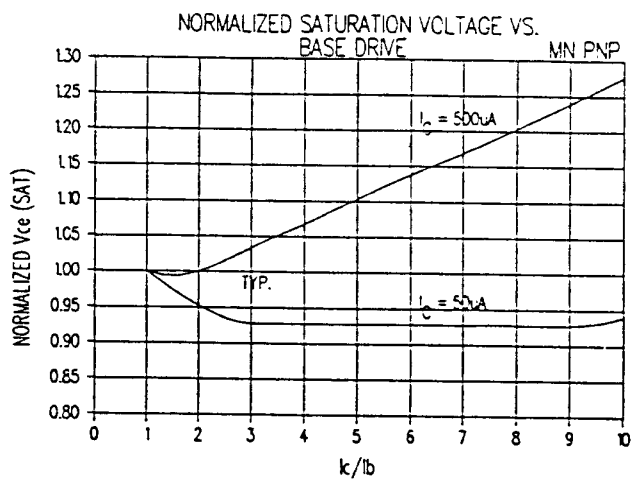
LATERAL PNP TRANSISTOR BEHAVIOR

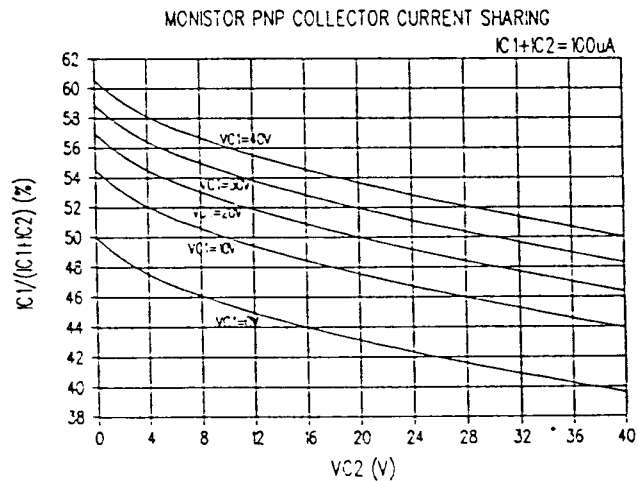
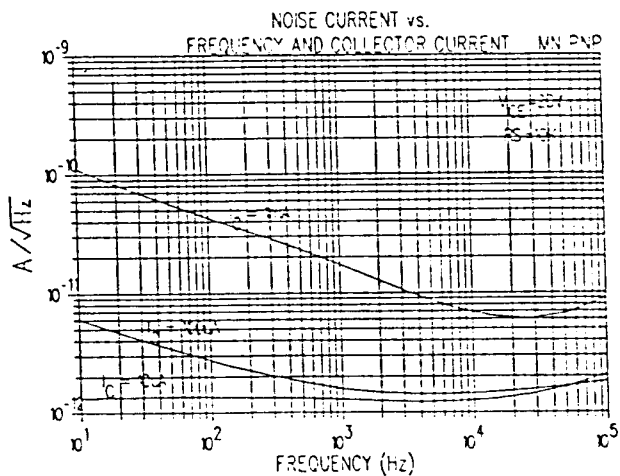
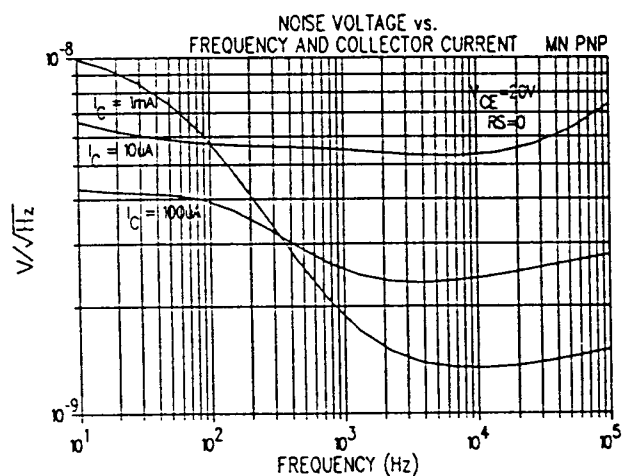
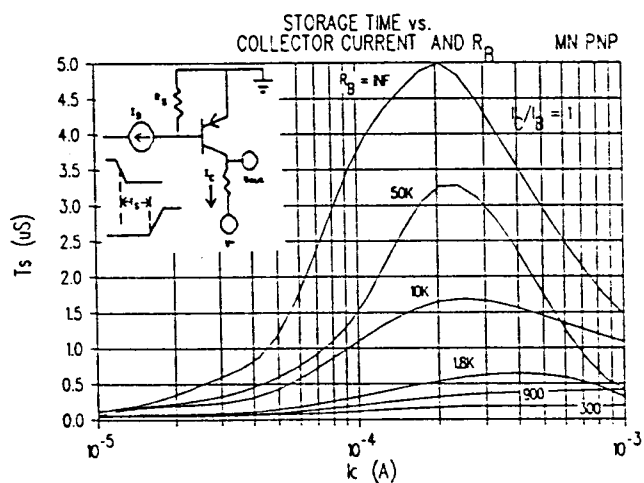
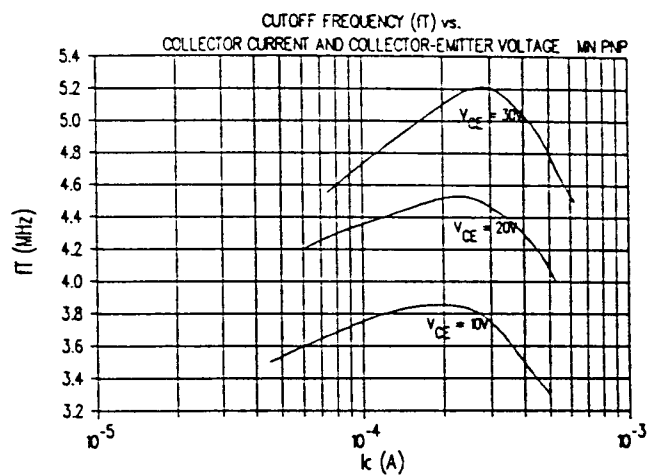
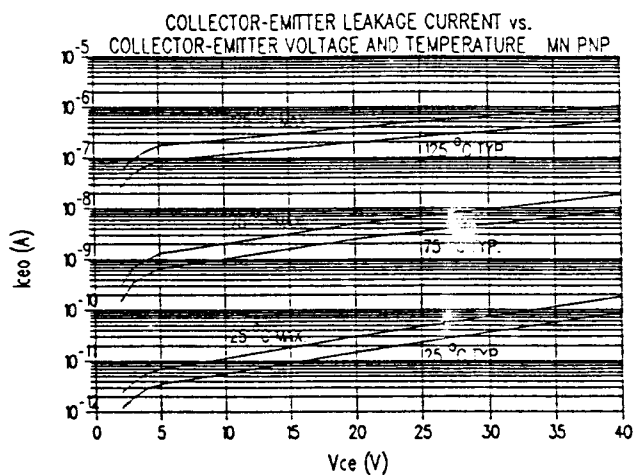
ELECTRICAL CHARACTERISTICS ($T_A = +25^\circ\text{C}$) MONISTOR PNP ("MN PNP")

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Forward Current Gain	β_F $V_{CE} = -20V, I_C = -100\mu A$	30		250	
Reverse Current Gain	β_R $V_{CE} = 20V, I_C = 100\mu A$		20		
Reverse Saturation Current	I_S		2.7×10^{-15}		A
Base Emitter Voltage	V_{BE} $V_{CE} = 20V, I_E = 100\mu A$	0.62		.74	V
Collector-Emitter Saturation Voltage	$V_{CE(SAT)}$ $I_C = 100\mu A, I_B = 100\mu A$			0.2	V
Emitter-Base Breakdown Voltage	V_{BEBO} $I_E = 10\mu A$	40			V
Collector-Emitter Breakdown Voltage	V_{CEO} $I_C = 100\mu A$	50			V
Collector-Base Breakdown Voltage	V_{CBO} $I_C = 10\mu A$	60			V
Collector-Emitter Leakage Current	I_{CEO} $V_{CE} = 40V$		100		pA
Collector-Base Leakage Current	I_{CBO} $V_{CB} = 40V$		7		pA
Collector Resistance	R_C $I_C = 0.2mA, I_B = 1mA$		50		Ω
Emitter Resistance	R_E $I_E = 5mA$		15		Ω
Base Resistance	R_B $I_C = 1mA$		150		Ω
Early Voltage	V_A $V_{CE} = 20V, I_C = 10\mu A$		60		V
Current Gain Bandwidth Product	f_T $V_{CE} = 20V, I_C = 200\mu A$		4.5		MHz
Forward Transit Time	T_F $V_{CE} = 20V, I_C = 200\mu A$		35		nSec
Base Emitter Capacitance	C_{BE0} $V_{BIAS} = 0V$		0.13		pF
Collector-Base Capacitance	C_{CB0} $V_{BIAS} = 0V$		0.65		pF
Collector-Substrate Capacitance	C_{CS0} $V_{BIAS} = 0V$		2.8		pF



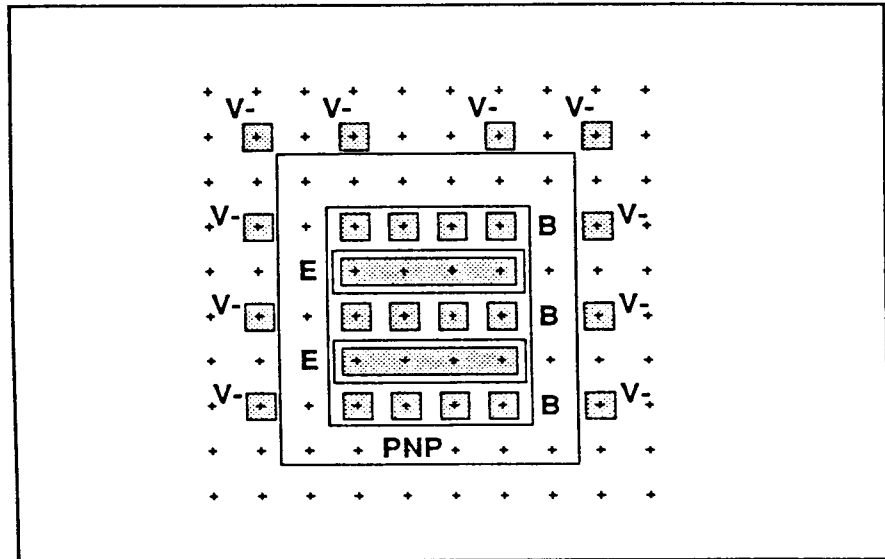




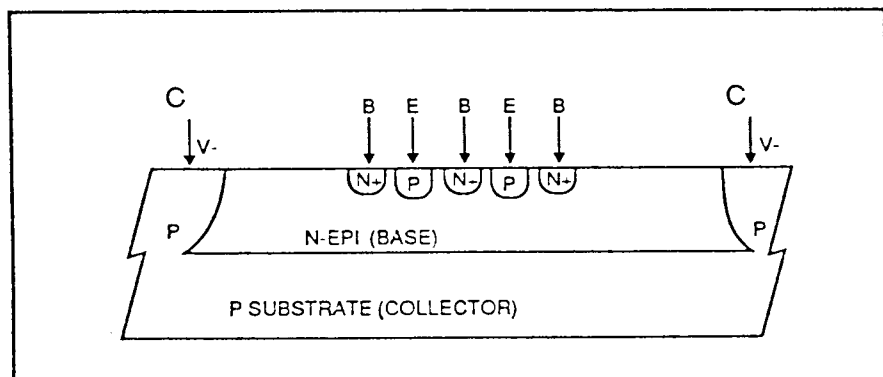


THE MV VERTICAL

The vertical PNP transistor, or "substrate PNP", is a peripheral component providing gain at higher current levels. Because the substrate serves as the collector of this device, its use is limited to situations in which the collector is connected to the negative-most power supply voltage (V_-). Contact to the substrate collector is made through the " V_- " contacts which surround the vertical PNP. There are two emitters, and one base region with multiple contacts. The emitter-base breakdown voltage is comparable to that of the NPN transistors, between 6.7 and 7.7 volts.



MV VERTICAL PNP TRANSISTOR ("VT PNP")



MV VERTICAL PNP TRANSISTOR CROSS SECTION

ELECTRICAL CHARACTERISTICS (Ta = +25°C) 1X NPN

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNITS
Forward Current Gain	βF	VCE=20V, IC=100μA	75		400	
Reverse Saturation Current	IS			2.8x10 ⁻¹⁴		A
Base Emitter Voltage	VBE	VCE=20V, IE=100μA	0.55			V
Collector-Emitter Saturation Voltage	VCE(SAT)	IC=1mA, IB=1μA				V
Emitter-Base Breakdown Voltage	BVEBO	IE=50μA	6.7			V
Collector-Emitter Breakdown Voltage	BVCEO	IC=10μA	50		0.73	V
Collector-Base Breakdown Voltage	BVCBO	IC=100μA	80		0.2	V
Collector-Emitter Leakage Current	ICEO	VCE=40V		70	7.7	pA
Collector-Base Leakage Current	ICBO	VCB=40V		7		pA
Collector Resistance	RC	IC=0.2mA, IB=1mA		15		Ω
Emitter Resistance	RE	IE=5mA		8		Ω
Base Resistance	RB	IC=1mA		100		Ω
Early Voltage	VA	VCE=20V, IC=100μA		70		V
Current Gain Bandwidth Product	fT	VCE=20V, IC=1mA		13		MHz
Forward Transit Time	TF	VCE=20V, IC=1mA		17		nSec
Base Emitter Capacitance	CBEO	VBIAS=0V		1.2		pF
Collector-Base Capacitance	CCBO	VBIAS=0V		1.1		pF

