November 2014

2N4401 / MMBT4401
NPN General-Purpose Amplifier

Description

This device is designed for use as a medium power amplifier and switch requiring collector currents up to 500 mA.

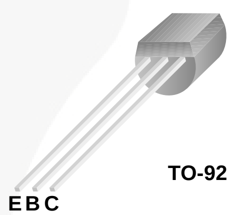


Figure 1. 2N4401 Device Package

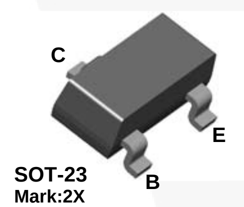


Figure 2. MMBT4401 Device Package

Ordering Information

Part Number	Marking	Package	Packing Method
2N4401BU	2N4401	TO-92 3L	Bulk
2N4401TF	2N4401	TO-92 3L	Tape and Reel
2N4401TFR	2N4401	TO-92 3L	Tape and Reel
2N4401TA	2N4401	TO-92 3L	Ammo
2N4401TAR	2N4401	TO-92 3L	Ammo
MMBT4401	2X	SOT-23 3L	Tape and Reel

Absolute Maximum Ratings[1],[2]

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Value	Unit
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	600	mA
T_J, T_{STG}	Operating and Storage Junction Temperature Range	-55 to +150	°C

Notes:

1. These ratings are based on a maximum junction temperature of 150°C.
2. These are steady-state limits. Fairchild Semiconductor should be consulted on applications involving pulsed or low-duty cycle operations.

Thermal Characteristics

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Max.		Unit
		2N4401[3]	MMBT4401[4]	
P_D	Total Device Dissipation	625	350	mW
	Derate Above 25°C	5.0	2.8	mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	°C/W

Notes:

3. PCB size: FR-4, 76 mm x 114 mm x 1.57 mm (3.0 inch x 4.5 inch x 0.062 inch) with minimum land pattern size.
4. Device mounted on FR-4 PCB 1.6 inch x 1.6 inch x 0.06 inch.

Electrical Characteristics

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Conditions	Min.	Max.	Unit
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage[5]	I_C = 1.0 mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 0.1 mA, I_E = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 0.1 mA, I_C = 0	6.0		V
I_{BL}	Base Cut-Off Current	V_{CE} = 35 V, V_{EB} = 0.4 V		0.1	µA
I_{CEX}	Collector Cut-Off Current	V_{CE} = 35 V, V_{EB} = 0.4 V		0.1	µA
h_{FE}	DC Current Gain[5]	I_C = 0.1 mA, V_{CE} = 1.0 V	20		
		I_C = 1.0 mA, V_{CE} = 1.0 V	40		
		I_C = 10 mA, V_{CE} = 1.0 V	80		
		I_C = 150 mA, V_{CE} = 1.0 V	100	300	
		I_C = 500 mA, V_{CE} = 2.0 V	40		
$V_{CE}(sat)$	Collector-Emitter Saturation Voltage[5]	I_C = 150 mA, I_B = 15 mA		0.40	V
		I_C = 500 mA, I_B = 50 mA		0.75	
$V_{BE}(sat)$	Base-Emitter Saturation Voltage[5]	I_C = 150 mA, I_B = 15 mA	0.75	0.95	V
		I_C = 500 mA, I_B = 50 mA		1.20	
f_T	Current Gain - Bandwidth Product	I_C = 20 mA, V_{CE} = 10 V, f = 100 MHz	250		MHz
C_{cb}	Collector-Base Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 140 kHz		6.5	pF
C_{eb}	Emitter-Base Capacitance	V_{BE} = 0.5 V, I_C = 0, f = 140 kHz		30	pF
h_{ie}	Input Impedance	I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz	1.0	15.0	kΩ
h_{re}	Voltage Feedback Ratio	I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz	0.1	8.0	$x10^{-4}$
h_{fe}	Small-Signal Current Gain	I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz	40	500	
h_{oe}	Output Admittance	I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz	1.0	30	µmhos
t_d	Delay Time	V_{CC} = 30 V, V_{EB} = 2 V, I_C = 150 mA, I_{B1} = 15 mA		15	ns
t_r	Rise Time			20	ns
t_s	Storage Time	V_{CC} = 30 V, I_C = 150 mA, I_{B1} = I_{B2} = 15 mA		225	ns
t_f	Fall Time			30	ns

Note:

5. Pulse test: pulse width ≤ 300 µs, duty cycle ≤ 2.0%.

Typical Performance Characteristics

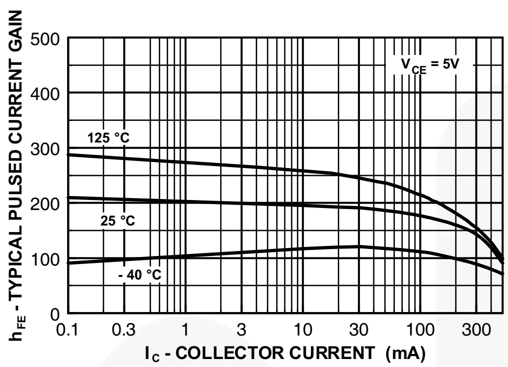


Figure 3. Typical Pulsed Current Gain vs. Collector Current

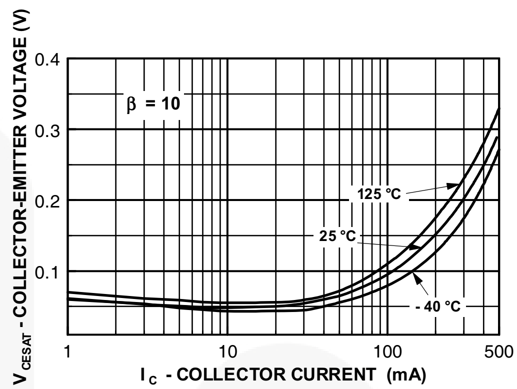


Figure 4. Collector-Emitter Saturation Voltage vs. Collector Current

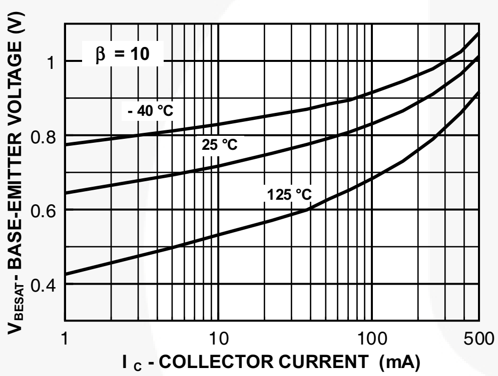


Figure 5. Base-Emitter Saturation Voltage vs. Collector Current

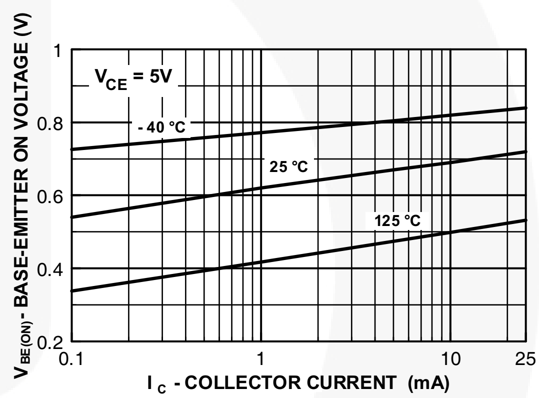


Figure 6. Base-Emitter On Voltage vs. Collector Current

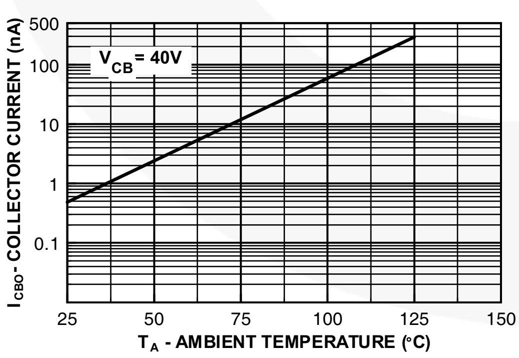


Figure 7. Collector Cut-Off Current vs. Ambient Temperature

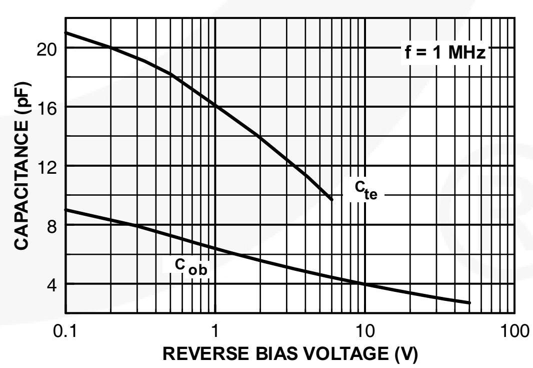


Figure 8. Emitter Transition and Output Capacitance vs. Reverse Bias Voltage

Typical Performance Characteristics (Continued)

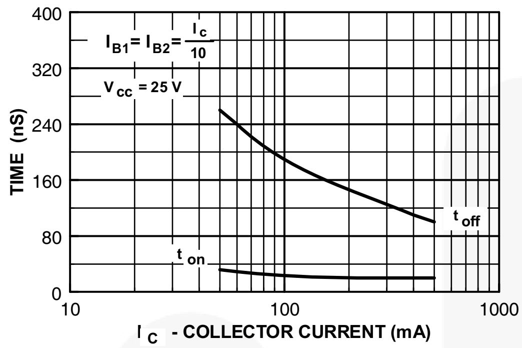


Figure 9. Turn-On and Turn-Off Times vs. Collector Current

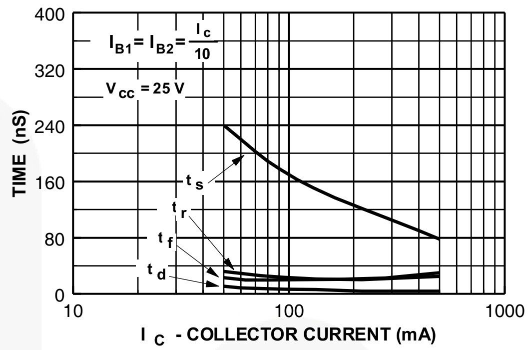


Figure 10. Switching Times vs.Collector Current

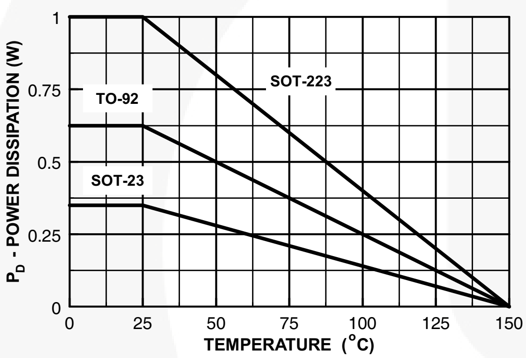


Figure 11. Power Dissipation vs. Ambient Temperature

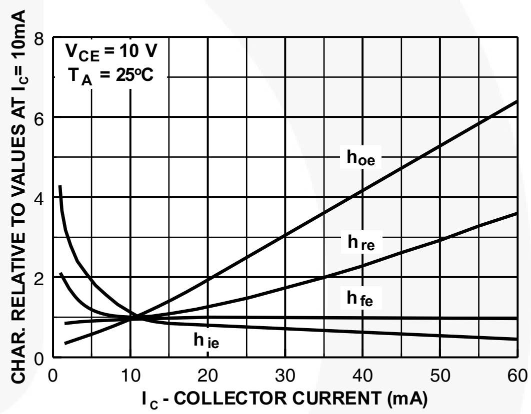


Figure 12. Common Emitter Characteristics

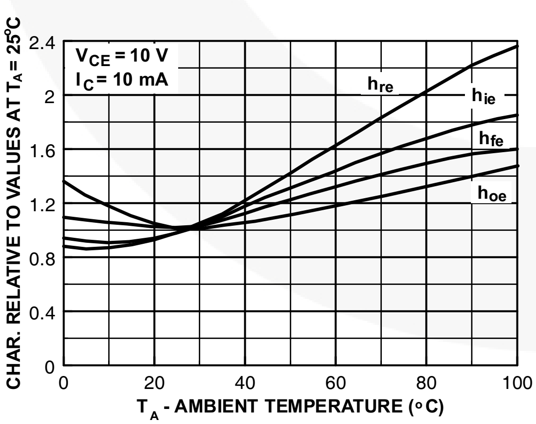


Figure 13. Common Emitter Characteristics

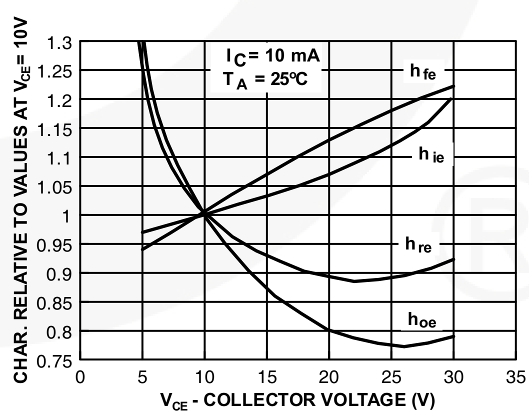
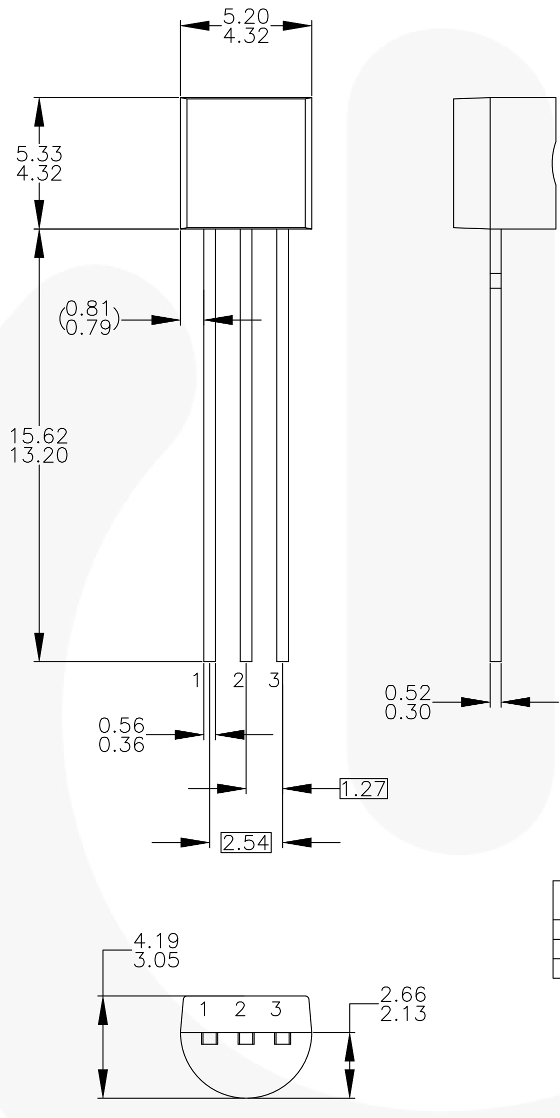


Figure 14. Common Emitter Characteristics

Physical Dimensions



NOTES: UNLESS OTHERWISE SPECIFIED

A) DRAWING WITH REFERENCE TO JEDEC TO–92 RECOMMENDATIONS.
B) ALL DIMENSIONS ARE IN MILLIMETERS.
C) DRAWING CONFORMS TO ASME Y14.5M–1994.
D) TO–92 (92,94,96,97,98) PIN CONFIGURATION:

PIN	92			94			96			97			98		
	P	F	M	P	F	M	B	F	M	P	F	M	P	F	M
1	E	S	S	E	S	S	B	D	G	C	G	D	C	G	D
2	B	D	G	C	G	D	E	S	S	B	D	G	E	S	S
3	C	G	D	B	D	G	C	G	D	E	S	S	B	D	G

LEGEND:
P – BIPOLAR
F – JFET
M – DMOS
E – EMITTER
B – BASE
C – COLLECTOR
D – DRAIN
S – SOURCE
G – GATE

E) FOR PACKAGE 92, 94, 96, 97 AND 98: PIN CONFIGURATION DRAIN "D" AND SOURCE "S" ARE INTERCHANGEAGLE AT JFET "F" OPTION.
F) DRAWING FILENAME: MKT–ZA03DREV3.

Figure 15. 3-Lead, TO-92, JEDEC TO-92 Compliant Straight Lead Configuration, Bulk Type

Physical Dimensions (Continued)

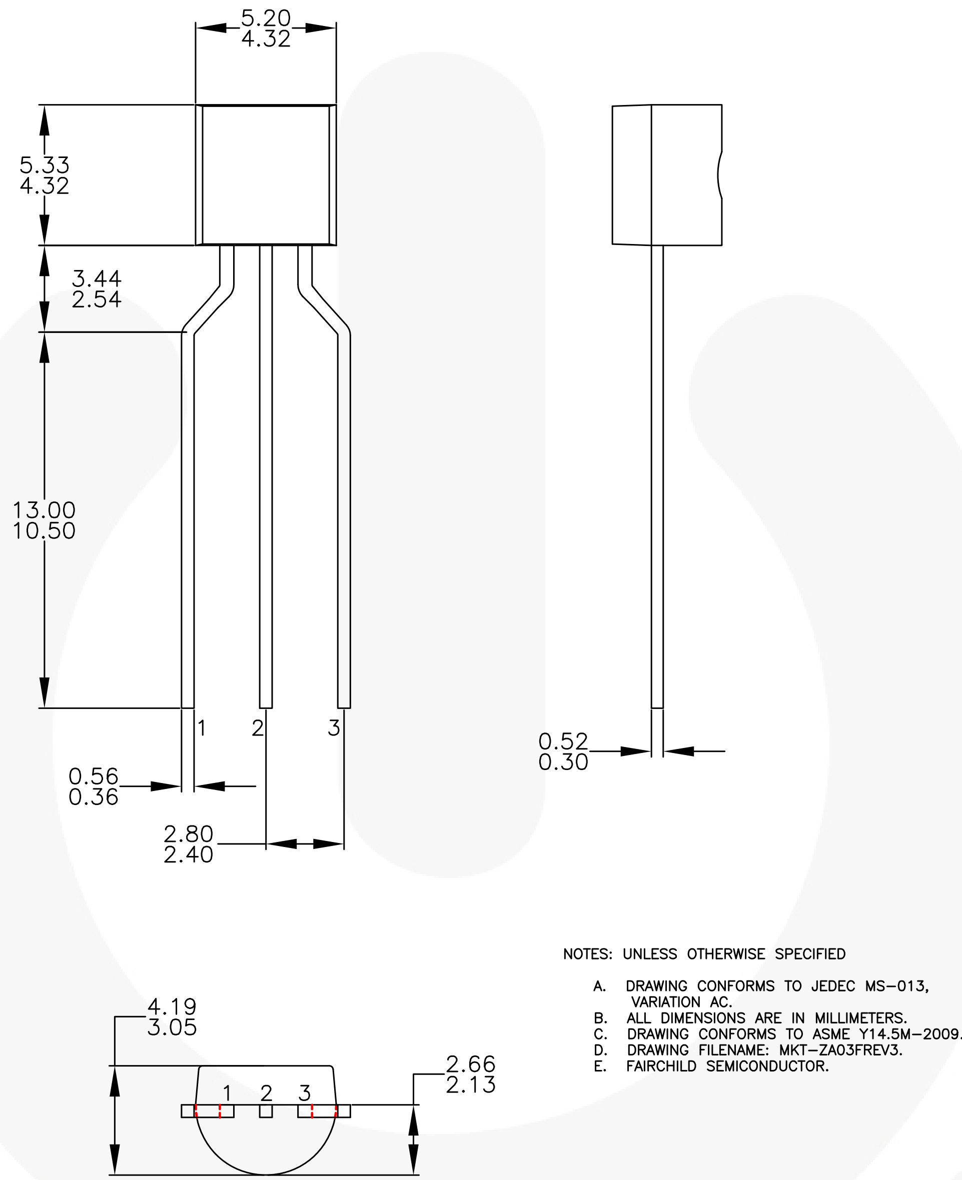


Figure 16. 3-Lead, TO-92, Molded, 0.2 In Line Spacing Lead Form, Ammo, Tape and Reel Type

Physical Dimensions (Continued)

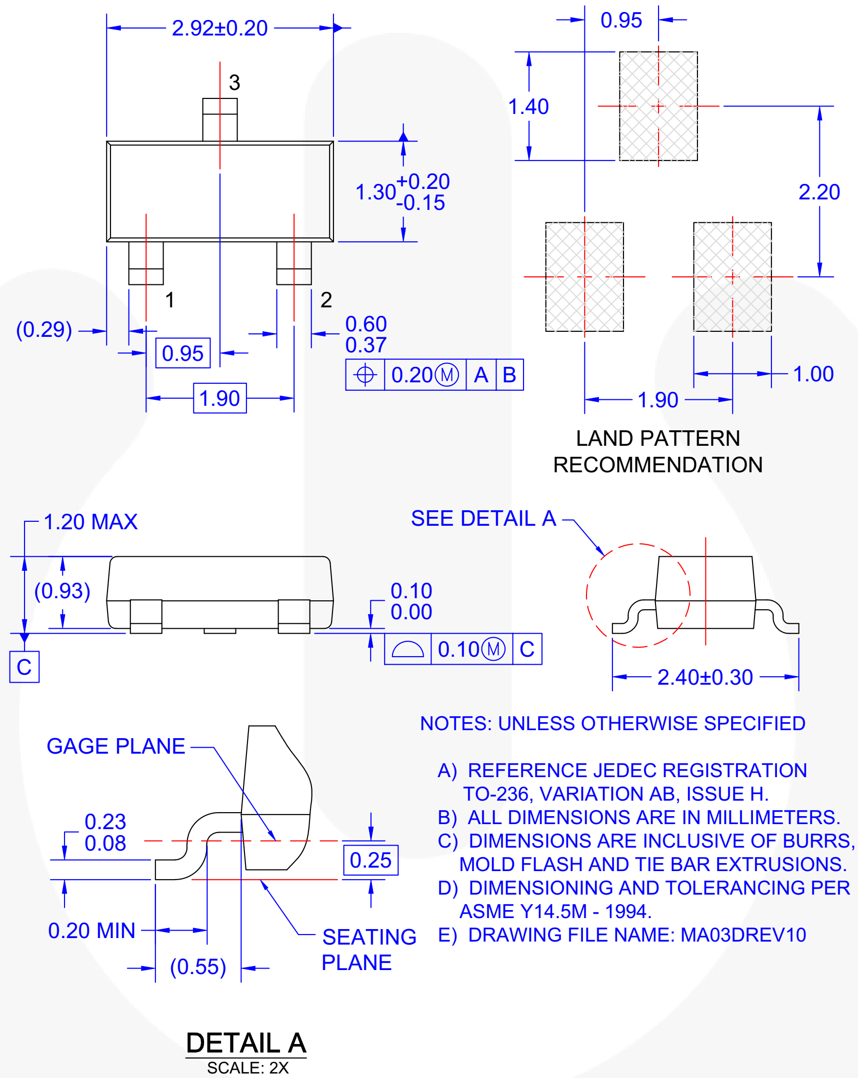


Figure 17. 3-LEAD, SOT23, JEDEC TO-236, LOW PROFILE

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Rev. I72