GENERAL INSTRUMENT	KB3600 KB3600-PRO

PRELIMINARY INFORMATION

PROGRAMABLE MICROCOMPUTER KEYBOARD ENCODERS

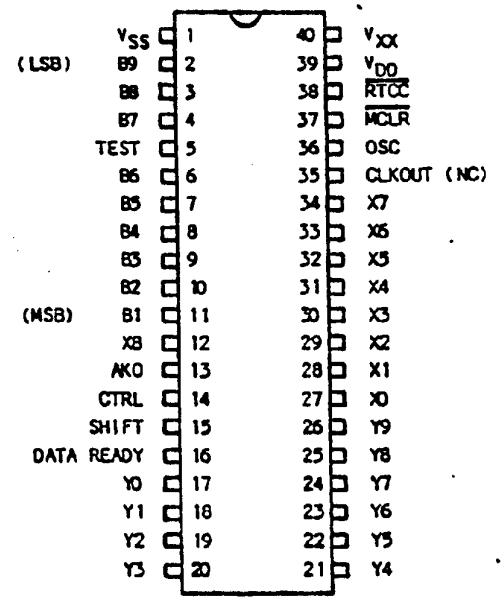
FEATURES

- Microcomputer-based keyboard encoders.
- N-key rollover or lock out operation.
- 9 output data bits.
- Output directly compatible with TTL/DTL or MOS.
- Output data buffer register included.
- Pulse or level Data Ready output signal.
- "Any Key Down" output signal.
- Mask programable keyswitch debouncing period.
- ASCII or binary (PRO) versions available.
- Auto repeat mask option.
- 4.5 - 7.0 volt operation

DESCRIPTION

The KB3600 Series is based on the General Instrument PIC1650A microcomputer, which is programed to be functionally equivalent to the General Instrument AY-5-3600 PMOS keyboard encoder. This PIC-based keyboard encoder is designed to scan a 90 key keyboard, organized in a 9 x 10 matrix, and output a 9 bit user-defined code when a key closure is detected. DATA, ANY KEY DOWN, and DATA READY outputs are all buffered and directly compatible with any TTL/DTL or MOS device without the need for any special interface components. A simple RC circuit can be used for the oscillator input.

PIN CONFIGURATION
40 LEAD DUAL IN LINE



34 Res Orig
005974
5974 GI

PIN FUNCTIONS

Signal	Function
OSC (input)	Oscillator input. This signal can be driven by an external oscillator if a precise frequency of operation is required, or an external RC network can be used to set the frequency of operation of the internal clock generator. This is a Schmitt trigger input.
$\overline{RTCC}$ (input)	Must be grounded for normal operation.
$\overline{MCLR}$ (input)	Master Clear. Used to initialize the internal ROM program to address 777_8 and latch all I/O register high. Should be held low at least 1ms past the time when the power supply is valid. This is a Schmitt trigger input.
CLK OUT (output)	Clock Out. This signal, one-fourth the oscillator frequency, is the instruction cycle frequency. No connection.
TEST	Used for testing purposes only. Must be grounded for normal operation.
V_{DD}, V_{XX}	4.5V - 7.0V power supply input.
V_{SS}	Ground.
B1-B9 (LC outputs)	Nine bits data output. B1 is the MSB and B9 is the LSB.
X0-X8 (outputs)	Nine scan rows of the keyboard.
Y0-Y9 (LC inputs)	Ten scan columns of the keyboard.
SHIFT (input)	SHIFT key input.
CTRL (input)	CONTROL key input.
AKO (output)	Any Key Down output
DATA READY (output)	This is the data strobe output. Activated when data is available on B1-B9.

MASK PROGRAMABLE FEATURES AND OPTIONS

The following mask programable options can be specified to suit individual requirements:

N-Key Rollover/N-Key Lockout

The KB3600 keyboard encoder is mask programed to operate in either N-key rollover or N-key lockout mode. In either case, the debouncing period is K X 108 microseconds where $1 \leq K \leq 255$. By specifying the value of K, the debouncing period can be customized.

a. N-Key Rollover

When a key closure is detected and the key has not been encoded, the switch debouncing routine is executed. If the key is still depressed at the end of the selected delay time, the 9 bit code for the depressed key is transferred to the data output lines. The DATA READY (strobe) signal is activated (either pulse or level output). Then the entire scanning process is started over again from coordinate X0, Y0. If another key closure is detected at some other coordinate, the entire sequence is repeated, thus encoding the next key. When a key closure is detected for an already encoded key, it is ignored. The code of the last key encoded remains on the output data lines until the next code is strobed out.

b. N-Key Lockout

When a key closure is detected, the debouncing routine is executed. If the key is still depressed at the end of the debouncing period, the code for the depressed key is transferred to the data output lines. The DATA READY signal is activated (either pulse or level output). The keyboard scanning action is halted until the depressed key is released. Upon release, the keyboard encoder resumes scanning from coordinate X0, Y0. The data output lines remain with the code for the last key encoded.

Pulse or Level DATA READY Signal

DATA READY can be either an active high or active low pulse, or level signal. If a pulse is chosen, the minimum pulse width is 52 microseconds.

ANY KEY DOWN OUTPUT

This signal is a level which can be either active high or active low. Whenever a key closure is detected, this signal is activated immediately with no debouncing period. Once activated, the ANY KEY DOWN signal will remain active until all keys are released.

Auto Repeat

If a single key closure condition sustains for a half second, the DATA READY signal will be asserted at a rate of 10 per second (i.e. one strobe every 100 milliseconds.) This auto strobing will stop immediately upon the release of the key or on the closure of another key. For the latter case, the codes for all depressed keys output singly without the auto repeat feature.

Parallel Data Output in ASCII or Binary

The 9 bit code can be output either in ASCII or binary format. Specify KB3600 for the ASCII version, or KB3600-PRO for the binary version.

During data output, bits 2-9 appear on the data lines at the same time. Bit 1 is output 8 microseconds later. After all nine bits are output, the DATA READY signal is activated.

ASCII Version Keyboard Encoder (KB3600)

The ASCII version provides an ASCII code output when a key is depressed.

The key coordinates are arranged to closely resemble a standard typewriter keyboard. See Figures 1 and 2.

PRO Version Keyboard Encoder (KB3600-PRO)

The PRO version provides a binary code output when a key is depressed. This binary code is the same as they key number of the key depressed. All keys are numbered from 00 to 89. The tens digit is the row number (X0-X8) and the units digit is the column number (Y0-Y9). For example, if the key at coordinate X2, Y3 is depressed, binary 23 is output. Seven bits (B1, B4-B9) are required to output binary 00 to 89 with B1 being the MSB. THe other two bits (B2, B3) are used to output the CONTROL and SHIFT key respectively. If CONTROL key is depressed, B2 is cleared. If SHIFT key is depressed , B3 is cleared. If both are depressed, both B2 and B3 are cleared.

Standard Features

The following are the standard features included in both the KB3600 and KB3600-PRO keyboard encoders:

- o 9 bit parallel data output
- o ANY KEY DOWN output-active high level
- o DATA READY output-active high pulse of 52us
- o Auto repeat at a rate of 10 characters per second
- o N-Key rollover
- o Debounce period-5.4ms (50 108us periods)

GENERAL INSTRUMENT	KB3600 KB3600-PRO

DIFFERENCES BETWEEN THE KB3600 KEYBOARD ENCODER AND THE AY-5-3600 KEYBOARD ENCODER

The following table gives a comparison of the two devices:*

Feature	KB3600	AY-5-3600
Maximum number of output data bit	9	10
Switch debouncing delay period	Mask programable 108-27650 µs.	Determined by external capacitor.
Power supply	+5V	+5V and -12V
N-Key rollover/lockout	Mask programable	Selection under external control
Output complement control	Data cannot be complemented without extra hardware inverters	Data can be complemented under external control
Chip Enable	No	Yes
ANY KEY DOWN output	Yes	Yes
DATA READY pulse width	52-104 µs	10-100 µs

*Timing data is based on t_{CY}=4.0 µs (f_{OSC} = 1 MHz.)

Limitation on Choosing the 9-Bit Data Output Coding Scheme

The keyboard has four modes (NORMAL, SHIFT, CONTROL, AND CONTROL SHIFT MODE) with 90 keys for each mode. This gives a total of 360 possible codes. The AY-5-3600 keyboard encoder is capable of outputing 360 distinct codes. The PIC1650A-based keyboard encoder can store only about 200 distinct codes. Therefore a relationship must exist between codes if more are required. For example, there are only 81 distinct codes for the KB3600. When the SHIFT key is depressed together with another key, a formula is used to transform the code from the NORMAL mode to the code for SHIFT mode. In the case of ASCII code, octal 40 is subtracted from the normal code to obtain the code for the SHIFT mode, and octal 140 is subtracted from the CONTROL AND CONTROL-SHIFT modes.

TIMING SPECIFICATIONS

Figure 1 shows the timing relation for different signals for parallel data output. (See above for the mask programable debouncing period.) If no key is depressed, 13ms are required to scan all 90 keys.

Figure 1
KB3600-ASCII KEYBOARD ENCODER CODE ASSIGNMENT

SYMBOL	NORMAL	SHIFT	CONTROL	CONTROL-SHIFT
(GRAVE)		X0Y8		
a	X0Y2			
b	X5Y3			
c	X2Y3			
d	X2Y2			
e	X2Y1			
f	X3Y2			
g	X4Y2			
h	X5Y2			
i	X7Y1			
j	X6Y2			
k	X7Y2			
l	X8Y2			
m	X7Y3			
n	X6Y3			
o	X8Y1			
p	X6Y6			
q	X0Y1			
r	X3Y1			
s	X1Y2			
t	X4Y1			
u	X6Y1			
v	X4Y3			
w	X1Y1			
x	X1Y3			
y	X5Y1			
z	X0Y3			
[		X3Y6		
|		X2Y8		
]		X4Y5		
		X6Y4		
DEL		X2Y9		
@	X0Y8			
A		X0Y2		
B		X5Y3		
C		X2Y3		
D		X2Y2		
E		X2Y1		
F		X3Y2		
G		X4Y2		
H		X5Y2		
I		X7Y1		
J		X6Y2		
K		X7Y2		
L		X8Y2		

KB3600-ASCII KEYBOARD ENCODER CODE ASSIGNMENT (continued)

SYMBOL	NORMAL	SHIFT	CONTROL	CONTROL-SHIFT
M		X7Y3		
N		X6Y3		
O		X8Y1		
P		X5Y6		
Q		X0Y1		
R		X3Y1		
S		X1Y2		
T		X4Y1		
U		X6Y1		
V		X4Y3		
W		X1Y1		
X		X1Y3		
Y		X5Y1		
Z		X0Y3		
[	X3Y6			
\	X2Y8			
]	X4Y5			
^	X6Y4			
_	X2Y9			
SPACE	X4Y9	X4Y9	X4Y9	X4Y9
!		X0Y0		
"		X1Y0		
#		X2Y0		
$		X3Y0		
%		X4Y0		
&		X5Y0		
'		X6Y0		
(		X7Y0		
)		X8Y0		
*		X5Y4		
+		X8Y5		
,	X8Y3			
-	X2Y4			
.	X8Y4			
/	X7Y4			
0	X8Y8	X8Y8	X8Y8	X8Y8
1	X0Y0			
2	X1Y0			
3	X2Y0			
4	X3Y0			
5	X4Y0			
6	X5Y0			
7	X6Y0			
8	X7Y0			
9	X8Y0			

KB3600-ASCII KEYBOARD ENCODER CODE ASSIGNMENT (continued)

SYMBOL	NORMAL	SHIFT	CONTROL	CONTROL-SHIFT
:	X5Y4			
;	X8Y5			
<		X8Y3		
=		X2Y4		
>		X8Y4		
?		X7Y4		
NUL			X0Y8	X0Y8
SOH			X0Y2	X0Y2
STX			X5Y3	X5Y3
ETX			X2Y3	X2Y3
EOT			X2Y2	X2Y2
ENQ			X2Y1	X2Y1
ACK			X3Y2	X3Y2
BEL			X4Y2	X4Y2
BS			X5Y2	X5Y2
HT			X7Y1	X7Y1
LF	X3Y9	X3Y9	X6Y2, X3Y9	X6Y2, X3Y9
VT			X7Y2	X7Y2
FF			X8Y2	X8Y2
CR	X1Y9	X1Y9	X7Y3, X1Y9	X7Y3, X1Y9
SO			X6Y3	X6Y3
SI			X8Y1	X8Y1
DLE			X6Y6	X6Y6
DC1			X0Y1	X0Y1
DC2			X3Y1	X3Y1
DC3			X1Y2	X1Y2
DC4			X4Y1	X4Y1
NAK			X6Y1	X6Y1
SYN			X4Y3	X4Y3
ETB			X1Y1	X1Y1
CAN			X1Y3	X1Y3
EM			X5Y1	X5Y1
SUB			X0Y3	X0Y3
ESC	X0Y9	X0Y9	X0Y9	X0Y9
FS			X2Y8	X2Y8
GS			X4Y5	X4Y5
RS			X6Y4	X6Y4
US			X2Y9	X2Y9

GENERAL INSTRUMENT	KB3600 KB3600-PRO

KB3600 ASCII Keyboard Encoder Code Assignment Chart

Y / X	0	1	2	3	4	5	6	7	8	9
0	! 1	DC1 DC1 Q q	SOH SOH A a	SUB SUB Z z					NUL NUL - @	ESC ESC ESC ESC
1	" 2	ETB ETB W w	DC3 DC3 S s	CAN CAN X x						CR CR CR CR
2	# 3	ENQ ENQ E e	EOT EOT D d	ETX ETX C c	= -				FS FS	US US DEL ___
3	$ 4	DC2 DC2 R r	ACK ACK F f							LF LF LF LF
4	% 5	DC4 DC4 T t	BEL BEL G g	SYN SYN V v		GS GS				SP SP SP SP
5	& 6	EM EM Y y	BS BS H h	STX STX B b	* :					
6	' 7	NAK NAK U u	LF LF J j	SO SO N n	RS RS			DLE DLE P p		
7	(8	HT HT I i	VT VT K k	CR CR M m	? /					
8	) 9	SI SI O o	FF FF L l	< ,	> .	+ ;			0 0 0 0	

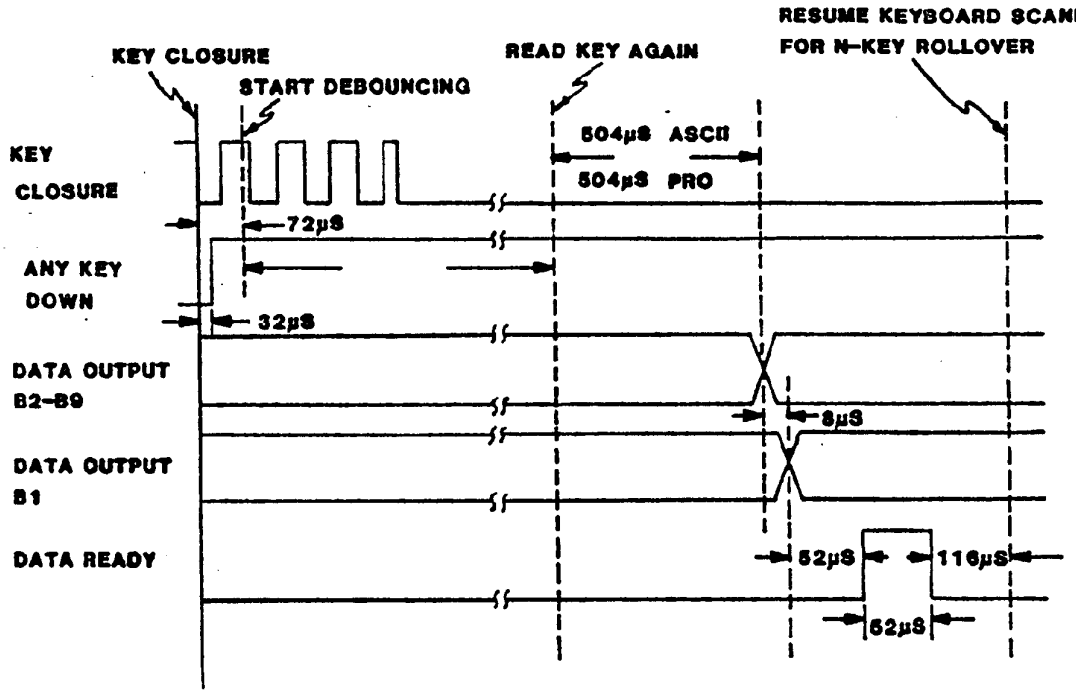
Notes:

The unused matrix locations can have user-defined (mask defined) codes. Consult your local General Instrument sales office if such a requirement exists.

Legend:

CONTROL-SHIFT	CONTROL
SHIFT	NORMAL

Fig. (1) Timing Diagram For Parallel Data Output[8]



Timing Based on T_{CY} = 4 µs (F_{OSS} = 1 MHz)

ELECTRICAL CHARACTERISTICS

Maximum Ratings*

Temperature Under Bias ..... 125°C
Storage Temperature ..... -55°C to +150°C
Voltage on any pin with
Respect to V_{SS}..... -0.3V to +12.0V
Power Dissipation 1000mW
Power Dissipated by any
one I/O pin (Note 1)..... 60mW
Power Dissipated by all
I/O pins (Note 1)..... 600mW

* Exceeding these ratings could cause permanent damage to the device. This is a stress rating only and functional operation of this device at these conditions is not implied - operating ranges are specified in Standard Condition. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Data labled "typical" is presented for design guidance only and is not guaranteed.

Standard Conditions (unless otherwise stated):

DC CHARACTERISTICS

Operating Temperature T_A = 0°C to +70°C

	Sym	Min	Typ	Max	Units	Conditions
Primary Supply Voltage	V_{DD}	4.5	-	7.0	V	
Output Buffer Supply Voltage	V_{XX}	4.5	-	10.0	V	(Note 2)
Primary Supply Current	I_{DD}	-	30	55	mA	All I/O pins high
Output Buffer Supply Current	I_{XX}	-	1	5	mA	All I/O pins high (Note 3)
Input Low Voltage	V_{IL}	-0.2	-	0.8	V	
Input High Voltage (except MCLR RTCC & OSC when driven externally)	V_{IH1}	2.4	-	V_{DD}	V	
Input High Voltage (MCLR, RTCC & OSC)	V_{IH2}	V_{DD}-1	2.6	V_{DD}	V	
Output High Voltage	V_{OH}	2.4	-	V_{DD}	V	I_{OH}<= -100µA provided by internal pullups (Note 4)
		3.5	-	V_{DD}		I_{OH} = 0
Output Low Voltage (I/O only)	V_{OL1}	-	-	0.45	V	I_{OL} = 1.6mA, V_{XX} = 4.5V
		-	-	0.90	V	I_{OL} = 5.0mA, V_{XX} = 4.5V
		-	-	0.90	V	I_{OL} = 5.0mA, V_{XX} = 8.0V
		-	-	1.20	V	I_{OL} = 10.0mA, V_{XX} = 8.0V
		-	-	2.0	V	I_{OL} = 20.0mA, V_{XX} = 8.0V (Note 5)
Output Low Voltage (CLKOUT)	V_{OL2}	-	-	0.45	V	I_{OL} = 1.6mA (Note 5)
Input Leakage Current (MCLR, RTCC)	I_{LC}	-5	-	+5	µA	$V_{SS} \leq V_{IN} \leq V_{DD}$
Output Leakage Current (open drain I/O pins)	I_{OLC}	-	-	10	µA	$V_{SS} \leq V_{PIN} \leq 10V$
Input Low Current (all I/O ports)	I_{IL}	-0.2	-0.6	-1.6	mA	V_{IL} = 0.4V internal pullup
Input High Current (all I/O ports)	I_{IH}	-0.1	-0.4	-1.4	mA	V_{IH} = 2.4V

NOTES:

1. Power dissipation for I/O pins is calculated by
   $\Sigma (V_{CC} - V_{IL})(|I_{IL}|) + \Sigma (V_{CC} - V_{OH})(|I_{OH}|) + \Sigma (V_{OL})(I_{OL})$.
   The term I/O refers to all interface pins: input, output or I/O.
2. V_{XX} supply drives only the I/O ports.
3. The maximum I_{XX} current will be drawn when all I/O ports are outputting a High.
4. Positive current indicates current into pin. Negative current indicates current out of a pin.
5. Total I_{OL} for all output pins (I/O ports plus CLK OUT) must not exceed 225mA.

Standard Conditions (unless otherwise stated):

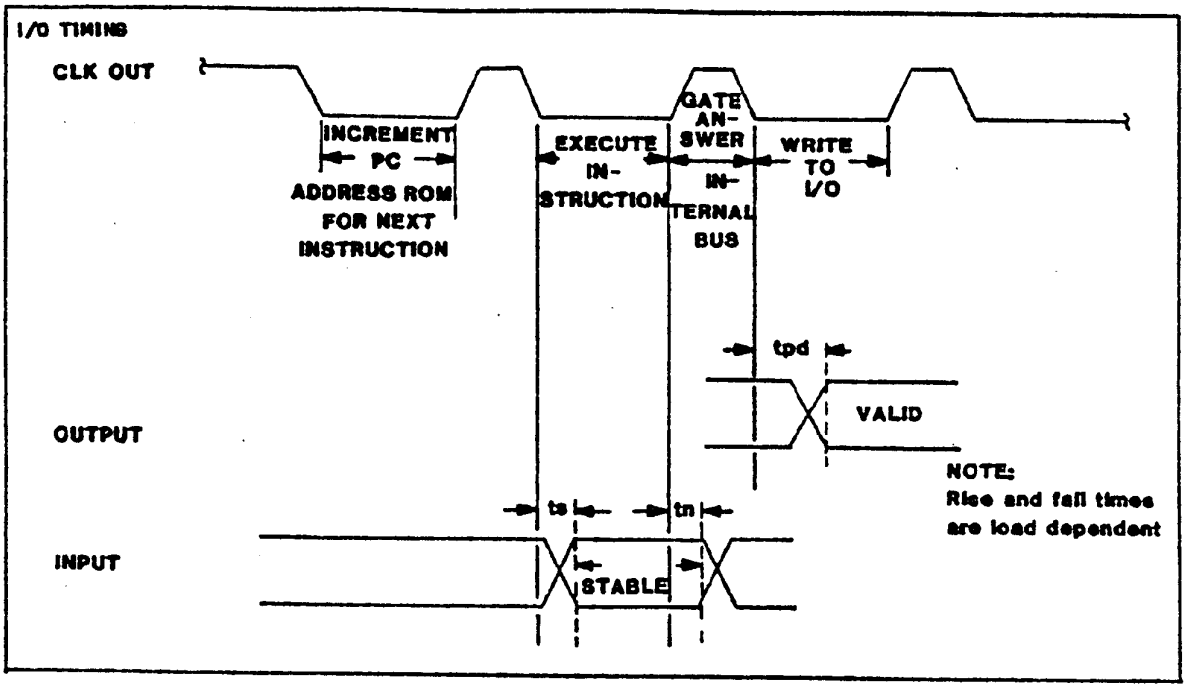
AC CHARACTERISTICS

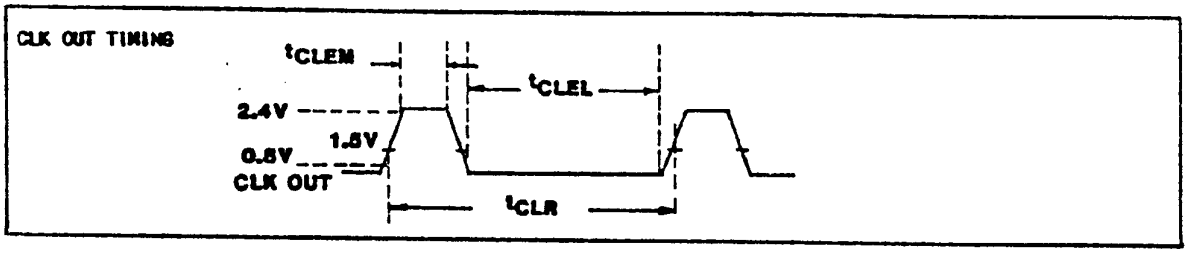
Operating Temperature T_A = 0°C to +70°C

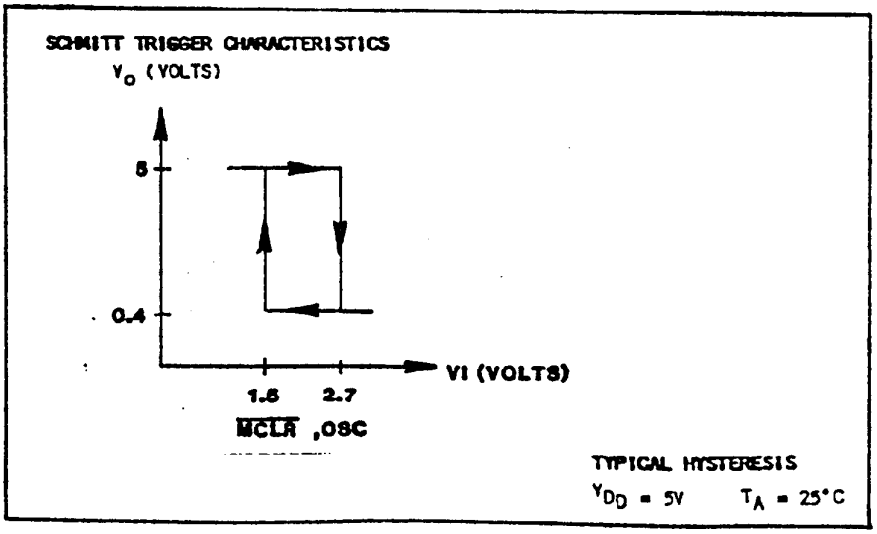
Characteristic	Sym	Min	Typ	Max	Units	Conditions
Instruction Cycle Time	T_{CY}	4	-	10	µs	0.4 - 1.0 MHz. external time base (Note 1)
I/O Ports						
Data Input Setup Time	T_S	-	-	1/4 t_{CY} -125	ns	
Data Input Hold Time	T_H	0	-	-	ns	
Data Output Propagation Delay	T_{PD}	-	500	800	ns	Capacitive load = 50 pF
OSC Input						
External Input Impedance High	R_{OSCH}	-	120	-		V_{OSC} = 5V
External Input Impedance Low	R_{OSCL}	-	10^6	-		V_{OSC} = 0.4V Applies to external OSC drive only

Notes:

1. Instruction cycle period (t_{CY}) equals four times the input oscillator time base period.



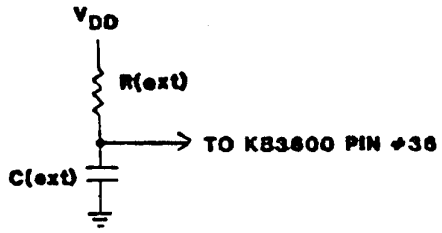


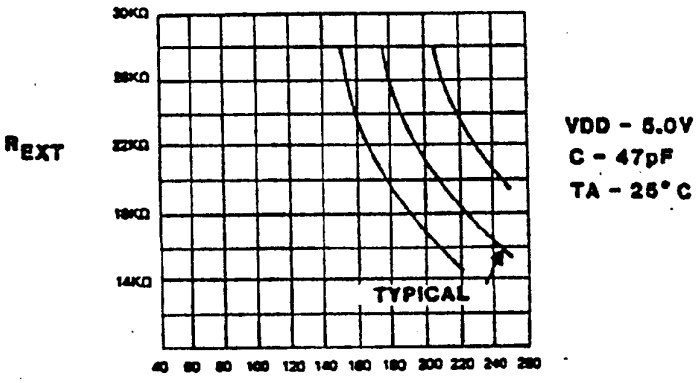


DS30012A-12

KB3600 OSCILLATOR OPTIONS (TYPICAL CIRCUITS)

RC OPTION OPERATION

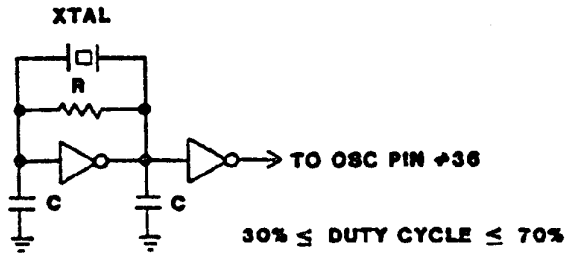




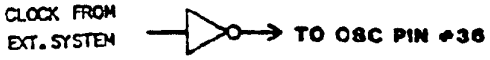
Oscillator Frequency With Typical Unit to Unit Variance

Unit to Unit Variation at V_{DD} = 5.0V, T_A = 25°C is ± 25%
Variation from V_{DD} = 4.5V - 7.0V referenced to 5V is -3%, +9%
Variation from T_A = 0°C - 70°C referenced to 25°C is +3%, -3%

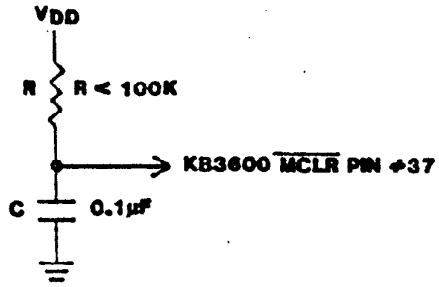
BUFFERED CRYSTAL INPUT OPERATION



EXTERNAL CLOCK INPUT OPERATION

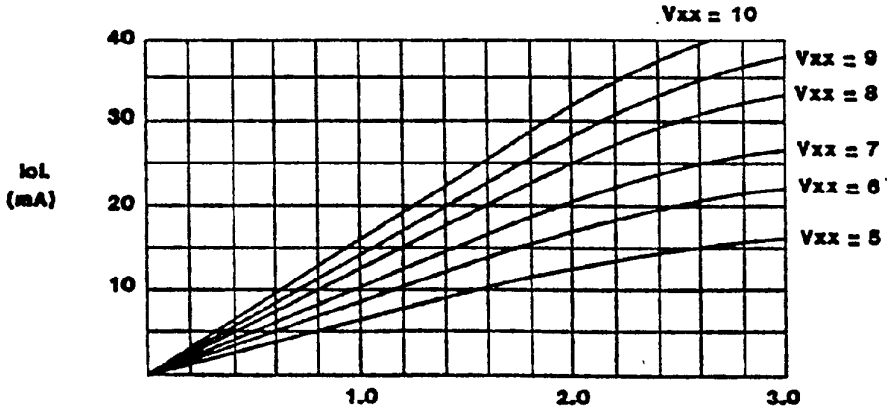


MASTER CLEAR



Master Clear requires >1.0ms delay before activation after power is applied to the V_{DD} pin. To achieve this, an external RC configuration as shown can be used (assuming V_{DD} is applied as a step function).

OUTPUT SINK CURRENT GRAPH

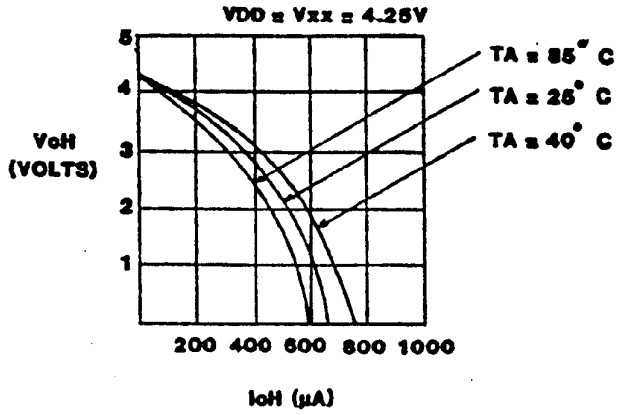


V_{OL} (VOLTS)

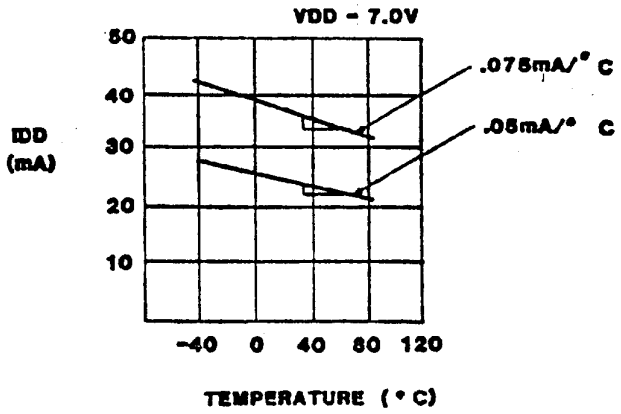
I_{OL} vs. V_{OL} TYP @ 25°C

The Output Sink Current is dependent on the V_{xx} supply and the output load. This chart shows the typical curves used to express the output drive capability.

V_{OH} VS I_{OH} (I/O PORTS)



POWER SUPPLY CURRENT VS TEMPERATURE



GENERAL INSTRUMENT	KB3600 ORDER FORM

Customer Name _____

Address _____

City _____ State _____ Zip _____ Country _____

Telephone Number _____ Ext. _____

Customer Contact _____ Title _____ Date _____

1. N-Key Rollover: Yes _____ No _____ (N-Key Lockout)

2. Debouncing period is: _____ 108 (microseconds)
(1-255)

3. DATA READY Signal:

   a. Active Level: High _____ Low _____

   b. Active Pulse: High _____ Low _____

      Pulse Width is: _____(microseconds)

      (52-104μs in 12μs. increments only)

4. ANY KEY DOWN Signal: Active High _____ Active Low _____

5. Auto Repeat at a rate of 10 characters per second: Yes _____ No _____

6. Code: _____ ASCII: KB3600 _____ Binary: KB3600-PRO _____ Customer Assigned _____
(Attach Code Assignment)