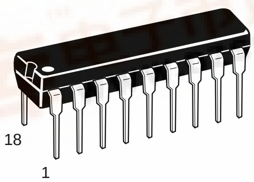
MC14497

PCM Remote Control Transmitter



P SUFFIX
PLASTIC DIP
CASE 707

ORDERING INFORMATION

MC14497P	Plastic DIP

The MC14497 is a PCM remote control transmitter realized in CMOS technology. Using a dual–single (FSK/AM) frequency bi–phase modulation, the transmitter is designed to work with the MC3373 receiver. Information on the MC3373 can be found in the Motorola *Linear* and *Interface Integrated Circuits* book (DL128/D).

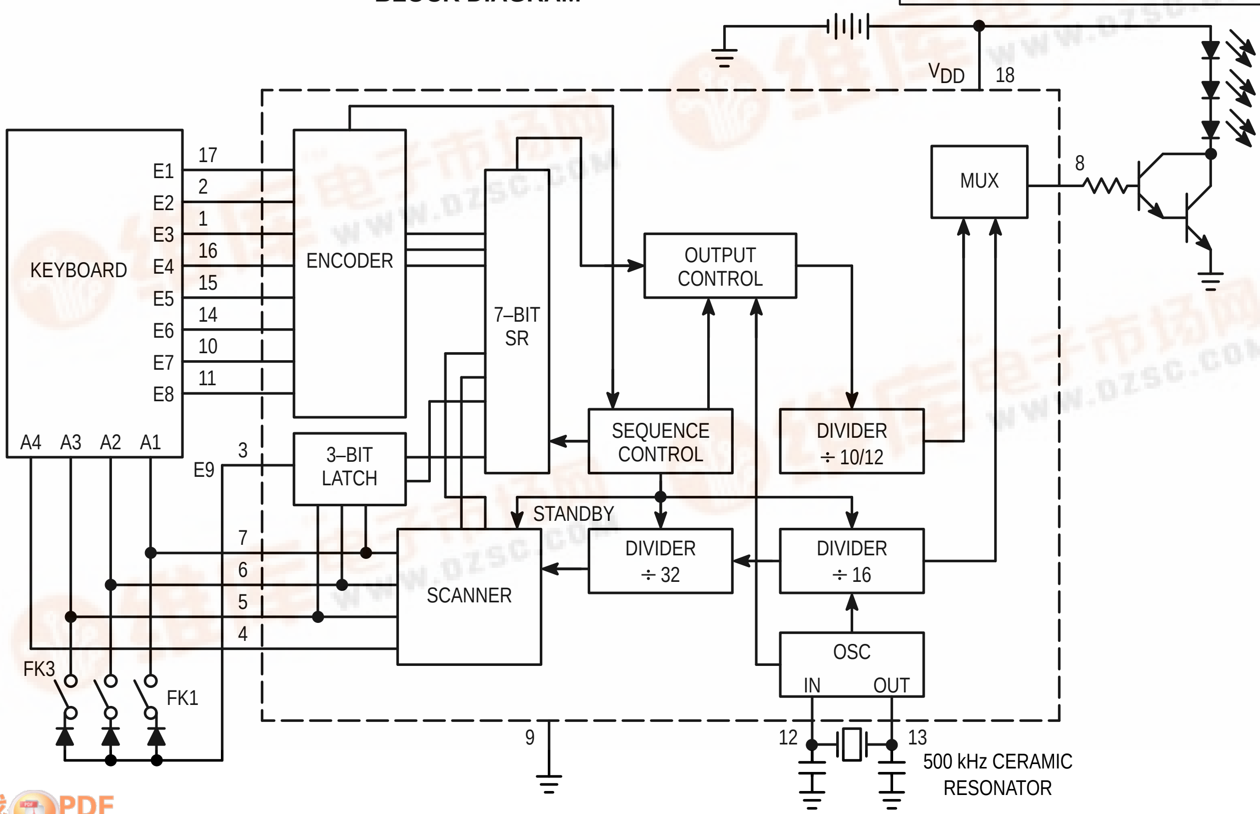
There is not a decoder device which is compatible with the MC14497. Typically, the decoding resides in MCU software.

- Both FSK/AM Modulation Selectable
- 62 Channels (Up to 62 Keys)
- Reference Oscillator Controlled by Inexpensive Ceramic Resonator: Maximum Frequency = 500 kHz
- Very Low Duty Cycle
- Very Low Standby Current: 50 µA Maximum
- Infrared Transmission
- Selectable Start–Bit Polarity (AM Only)
- Shifted Key Mode Available
- Wide Operating Voltage Range: 4 to 10 V
- See Application Notes AN1016 and AN1203

PIN ASSIGNMENT

E3	1	18	V_{DD}
E2	2	17	E1
E9	3	16	E4
A4	4	15	E5
A3	5	14	E6
A2	6	13	OSC_{out}
A1	7	12	OSC_{in}
SIGNAL OUT	8	11	E8
V_{SS}	9	10	E7

BLOCK DIAGRAM



MAXIMUM RATINGS (Voltages referenced to V_{SS})

Parameter	Symbol	Value	Unit
DC Supply Voltage	V_{DD}	– 0.5 to + 18	V
Input Voltage, All Inputs	V_{in}	– 0.5 to V_{DD} + 0.5	V
DC Current Drain per Pin	I	10	mA
Operating Temperature Range	T_A	– 40 to + 85	°C
Storage Temperature Range	T_{stg}	– 65 to + 150	°C

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high–impedance circuit. For proper operation it is recommended that V_{in} and V_{out} be constrained to the range $V_{SS} \leq (V_{in}$ or $V_{out}) \leq V_{DD}$.

ELECTRICAL CHARACTERISTICS (T_A = 0 to 70°C; all Voltages Referenced to V_{SS})

Characteristic		Symbol	V_{DD}	Min	Max	Unit
Supply Voltage		V_{DD}	—	4.0	10.0	V
Supply Current		I_{DD}				
Idle			10	—	50	µA
Operation			10	—	5	mA
Output Current — Signal						µA
V_{OH} = 3.0 V	Source	I_{OH}	4	– 900	—	
V_{OL} = 0.5 V	Sink	I_{OL}	4	120	—	
Output Current — Scanner						µA
V_{OH} = 3.0 V	Source	I_{OH}	4	– 30	—	
V_{OL} = 0.5 V	Sink	I_{OL}	4	245	—	
Output Current — Oscillator						µA
V_{OH} = 3.0 V	Source	I_{OH}	4	– 300	—	
V_{OL} = 0.5 V	Sink	I_{OL}	4	245	—	
Input Current — Oscillator		I_{in}				µA
Operation			10	± 2	± 80	
Idle, V_{IL} = 0.5 V			4	30	—	
Input Current — Encoder		I_{in}				µA
V_{IH} = 9.0 V			10	– 15	—	
V_{IL} = 0.5 V			4	—	– 60	
Input Voltage — Encoder		V_{IH}	10	9	—	V
		V_{IL}	10	—	1.2	
		V_{IH}	4	3	—	
		V_{IL}	4	—	1.0	

CIRCUIT OPERATION

The transmitter sends a 6–bit, labelled A (LSB) to F (MSB), binary code giving a total of 64 possible combinations or code words. All of these channels are user selectable, except the last two (where channel 63 is not sent while channel 62 is automatically sent by the transmitter at the end of each transmission as an “End of Transmission” code).

In either mode, FSK or AM, the transmitted signal is in the form of a bi–phase pulse code modulation (PCM) signal. The AM coding is shown in Figure 1.

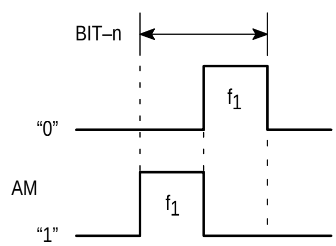


Figure 1. AM Coding

In the AM mode, f_1 is a train of pulses at the modulating frequency of 31.25 kHz for a reference frequency of 500 kHz.

In the FSK mode, two modulating frequencies are used as shown in Figure 2.

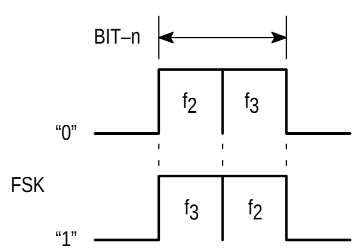


Figure 2. FSK Coding

In this mode, f_3 is 50 kHz and f_2 is 41.66 kHz for a reference frequency of 500 kHz.

The keyboard can be a simple switch matrix using no external diodes, connected to the four scanner inputs (A1 – A4) and the eight row input (E1 – E8). Under these conditions, only the first 32 code words are available since bit–F is always at logical 0. However, a simple 2–pole changeover switch, in the manner of a typewriter “shift” key (switch FK3 in the Block Diagram) can be used to change the polarity of bit–F to give access to the next full set of 32 instructions.

An alternative method of accessing more than 32 instructions is by the use of external diodes between the address inputs (see Figure 3). These have the effect of producing “phantom” address inputs by pulling two inputs low at the same time, which causes bit–F to go high (i.e., to logical 1). By interconnecting only certain address inputs it is possible to make an intermediate keyboard with between 32 and 64 keys.

The other two switches in the Block Diagram (FK1 and FK2) change the modulation mode. Closing FK1 changes the modulation from FSK to AM and the start–bit polarity. Closing FK2 changes the start–bit to a logical 0.

The full range of options available is illustrated in Table 1.

Table 1.

	Start Bit	Modulation	Bit–F	Channels
E9 = Open	1	FSK	0	0 – 31
E9 = A1 (FK1)	1	AM	0	0 – 31
E9 = A2 (FK2)	0	FSK	0	0 – 31*
E9 = A3 (FK3)	1	FSK	1	32 – 61
E9 = A1 • A2	0	AM	0	0 – 31
E9 = A1 • A3	1	AM	1	32 – 61
E9 = A2 • A3	0	FSK	1	32 – 61*
E9 = A1 • A2 • A3	0	AM	1	32 – 61

* Not allowed.

One of the transmitter’s major features is its low power consumption (in the order of 10 µA in the idle state). For this reason, the battery is perpetually in circuit. It has in fact been found that a light discharge current is beneficial to battery life.

In its active state, the transmitter efficiency is increased by the use of a low duty cycle which is less than 2.5% for the modulating pulse trains.

While no key is pressed, the circuit is in its idle state and the reference oscillator is stopped. Also, the eight address input lines are held high through internal pull–up resistors.

As soon as a key is pressed, this takes the appropriate address line low, signaling to the circuit that a key has been selected. The oscillator is now enabled. If the key is released before the code word has been sent, the circuit returns to its idle state. To account for accidental activation of the transmitter, the circuit has a built–in reactive time of approximately 20 ms, which also overcomes contact bounce. After this delay, the code word will be sent and repeated at 90 ms intervals for as long as the key is pressed. As soon as the key is released, the circuit automatically sends channel 62, the “End of Transmission” (EOT) code. The transmitter then returns to its idle state.

The differences between the two modulation modes are illustrated in Figure 4. However, it should be noted that in the AM mode, each transmitted word is preceded by a burst of pulses lasting 512 µs. This is used to set up the AGC loop in the receiver’s preamp. In the FSK mode, the first frequency of the first bit is extended by 1.5 ms and the AGC burst is suppressed. In either mode, it is assumed that the normal start–bit is present.

PIN DESCRIPTIONS

E1 – E8
Row Inputs (Pins 1, 2, 10, 11, 14, 15, 16, 17)

Under idle conditions, these inputs are held high by internal pull–up resistors. As soon as a key is pressed, a logical 0 on that particular line signals to the circuit that a key has been selected. After a delay of 20 ms, the internal register is loaded with the code word for the key selected.

E9
Row Input (Pin 3)

This is a special programming input and when connected to the appropriate scanner output via a diode, it will modify the transmitted output according to Table NO TAG.

In Table NO TAG, the figures in brackets (FK1, etc.) refer to the switches shown in the Block Diagram and Figure 3. If only one option is required, the diode may be omitted. The connections shown in Table NO TAG may be made in any combination.

Although E9 is a row input, forcing this line low will not activate the circuit.

A1 – A4
Scanner Outputs (Pins 4 – 7)

Under idle conditions, these outputs are held low, logical 0. When a key is pressed, the circuit is activated and the oscillator will start and release the outputs (see Figure 5).

OSC_{in}, OSC_{out}
Oscillator Input and Oscillator Output (Pins 12, 13)

These pins are designed to operate with a 500 kHz ceramic resonator or a tune LC circuit. It is important that a ceramic resonator and **not a filter** be used here, as the oscillator frequency cannot be guaranteed if a ceramic filter is used.

SIGNAL OUT
Signal Output (Pin 8)

This output provides the modulating signal ready to drive the modulation amplifier. If required, the transmitter can be used as a keyboard encoder for direct use with a receiver. In this case, the AM option is selected, the output inverted, and fed directly to the receiver's signal input pin.

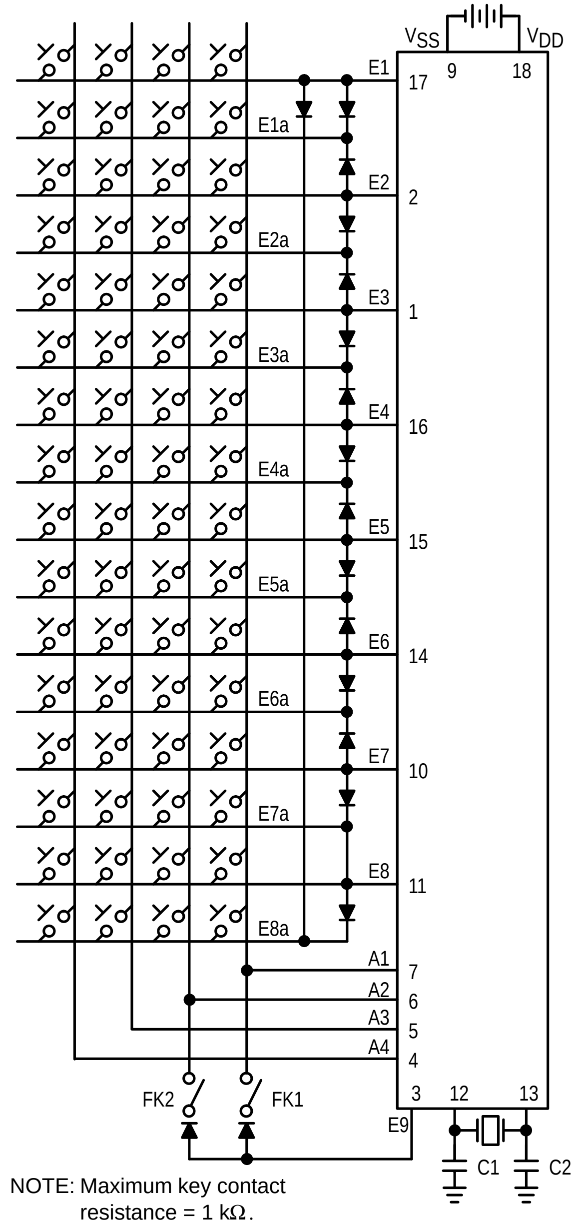


Figure 3. 64–Key Keyboard

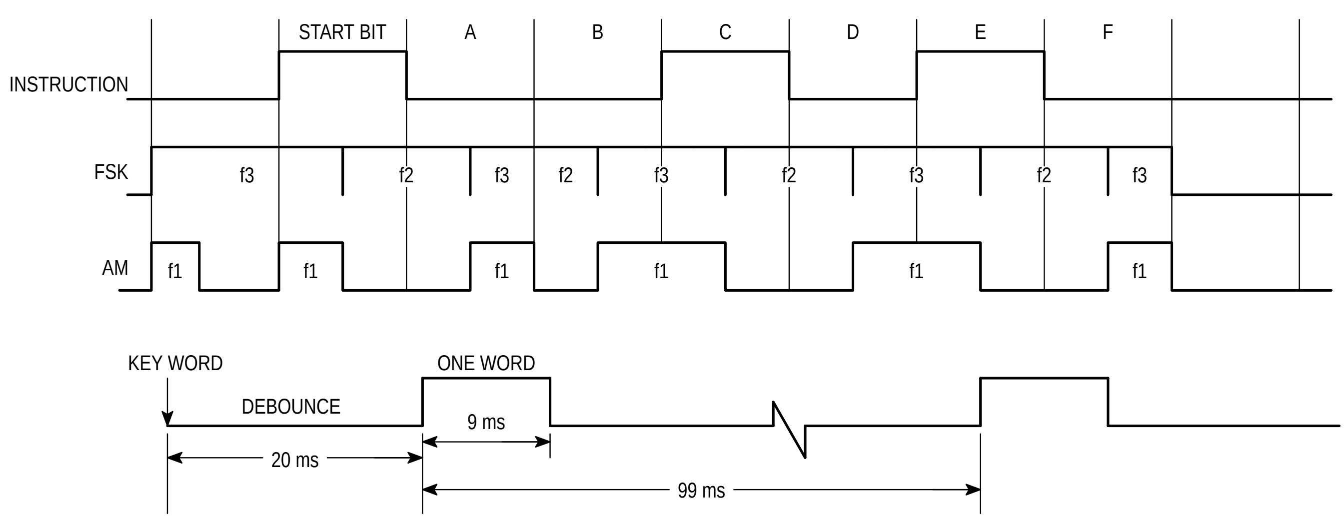


Figure 4. Transmitted Waveforms and Timing (Not Drawn to Scale)

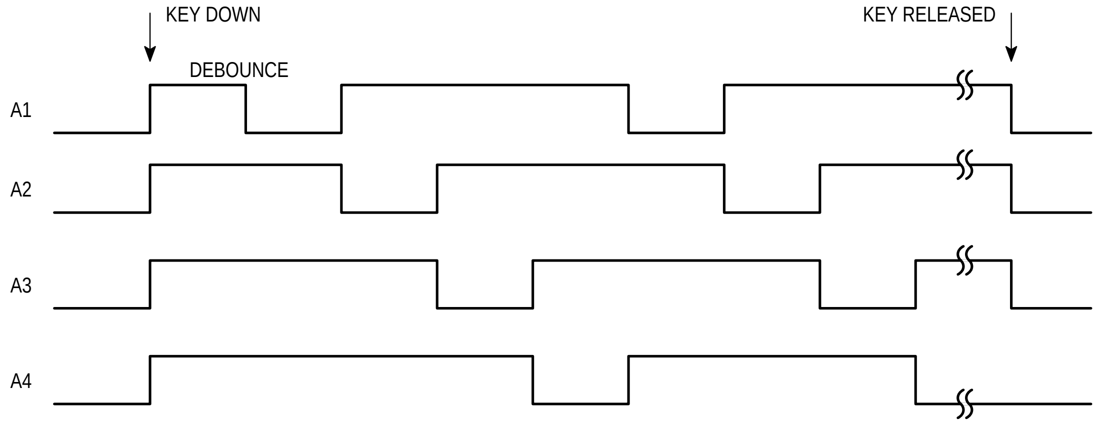
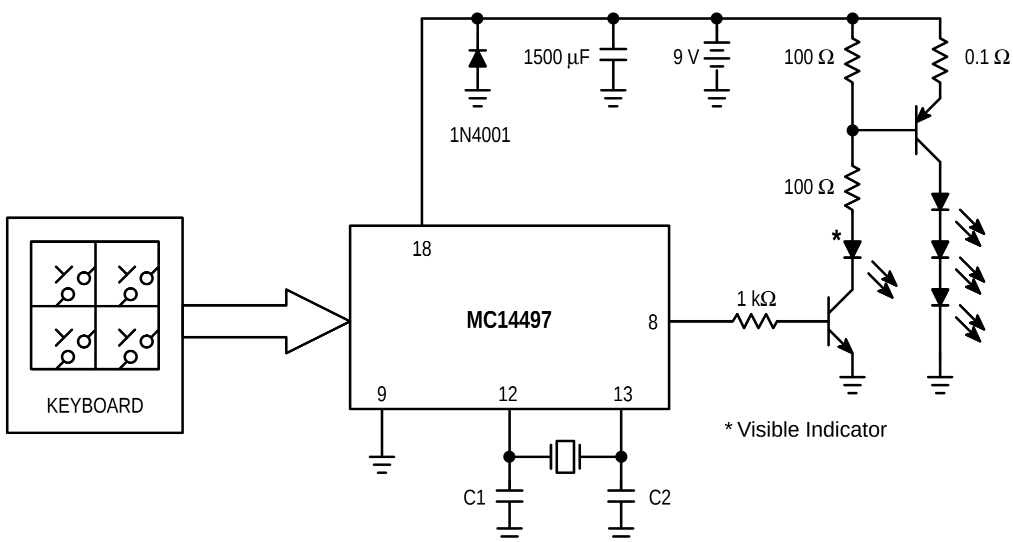


Figure 5. Scanner Output Timing Diagram

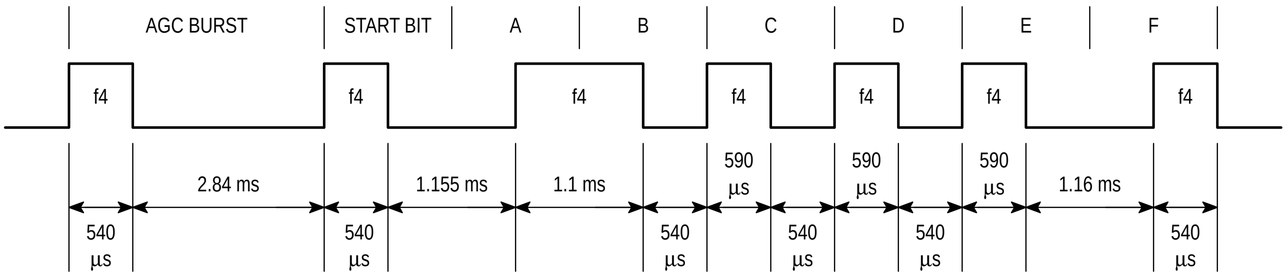


C1 and C2 are sized per the ceramic resonator supplier's recommendation.
Ceramic Resonator Suppliers:

1. Morgan Matrox, Inc., Bedford, OH, 216/232–8600
2. Radio Materials Co., Attica, IN, 317/762–2491

Motorola cannot recommend one supplier over another and in no way suggests that this is a complete listing of ceramic resonator suppliers.

Figure 6. Typical Application Circuit



NOTES:
1. f4 = 28.4 kHz.
2. Indicated time durations are approximated.

Figure 7. AM Mode Transmitted Wavetrain with 455 kHz Oscillator

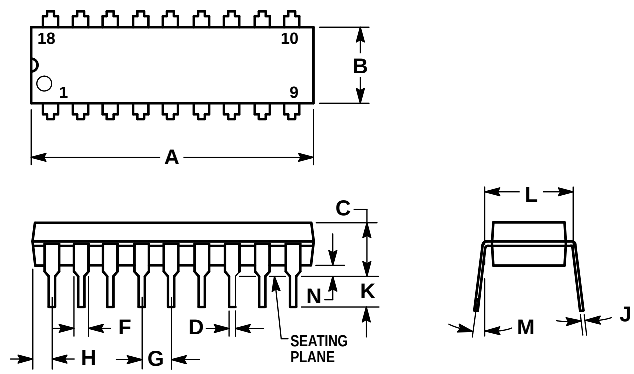
Table 2. Transmitted Codes

	Code Word						Keyboard			Code Word						Keyboard	
Channel	**F**	**E**	**D**	**C**	**B**	**A**	**In**	**Out**	**Channel**	**F**	**E**	**D**	**C**	**B**	**A**	**In**	**Out**
0	0	0	0	0	0	0	E8	A4	32	1	0	0	0	0	0	E8a	A4
1				0	0	1	E1	A4	33				0	0	1	E1a	A4
2				0	1	0	E2	A4	34				0	1	0	E2a	A4
3				0	1	1	E3	A4	35				0	1	1	E3a	A4
4				1	0	0	E4	A4	36				1	0	0	E4a	A4
5				1	0	1	E5	A4	37				1	0	1	E5a	A4
6				1	1	0	E6	A4	38				1	1	0	E6a	A4
7				1	1	1	E7	A4	39				1	1	1	E7a	A4
8	0	0	1	0	0	0	E8	A1	40	1	0	1	0	0	0	E8a	A1
9				0	0	1	E1	A1	41				0	0	1	E1a	A1
10				0	1	0	E2	A1	42				0	1	0	E2a	A1
11				0	1	1	E3	A1	43				0	1	1	E3a	A1
12				1	0	0	E4	A1	44				1	0	0	E4a	A1
13				1	0	1	E5	A1	45				1	0	1	E5a	A1
14				1	1	0	E6	A1	46				1	1	0	E6a	A1
15				1	1	1	E7	A1	47				1	1	1	E7a	A1
16	0	1	0	0	0	0	E8	A3	48	1	1	0	0	0	0	E8a	A3
17				0	0	1	E1	A3	49				0	0	1	E1a	A3
18				0	1	0	E2	A3	50				0	1	0	E2a	A3
19				0	1	1	E3	A3	51				0	1	1	E3a	A3
20				1	0	0	E4	A3	52				1	0	0	E4a	A3
21				1	0	1	E5	A3	53				1	0	1	E5a	A3
22				1	1	0	E6	A3	54				1	1	0	E6a	A3
23				1	1	1	E7	A3	55				1	1	1	E7a	A3
24	0	1	1	0	0	0	E8	A2	56	1	1	1	0	0	0	E8a	A2
25				0	0	1	E1	A2	57				0	0	1	E1a	A2
26				0	1	0	E2	A2	58				0	1	0	E2a	A2
27				0	1	1	E3	A2	59				0	1	1	E3a	A2
28				1	0	0	E4	A2	60				1	0	0	E4a	A2
29				1	0	1	E5	A2	61				1	0	1	E5a	A2
30				1	1	0	E6	A2	62				1	1	0	E6a	A2
31	0	1	1	1	1	1	E7	A2	Not Transmitted	1	1	1	1	1	1	E7a	A2

NOTE: Although the “a” suffix applies to a phantom input when using a keyboard with up to 64 keys, the coding is identical with a 32–key keyboard when switch FK3 is closed.

PACKAGE DIMENSIONS

P SUFFIX
PLASTIC DIP
CASE 707–02



NOTES:
1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25 (0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	22.22	23.24	0.875	0.915
B	6.10	6.60	0.240	0.260
C	3.56	4.57	0.140	0.180
D	0.36	0.56	0.014	0.022
F	1.27	1.78	0.050	0.070
G	2.54 BSC		0.100 BSC	
H	1.02	1.52	0.040	0.060
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040

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