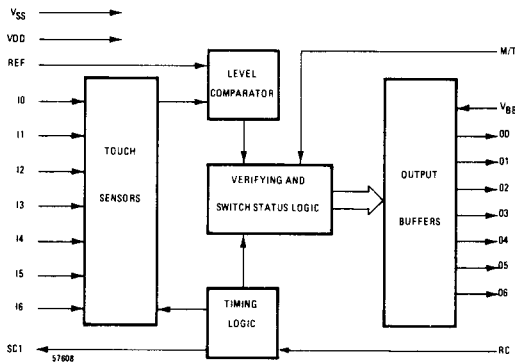
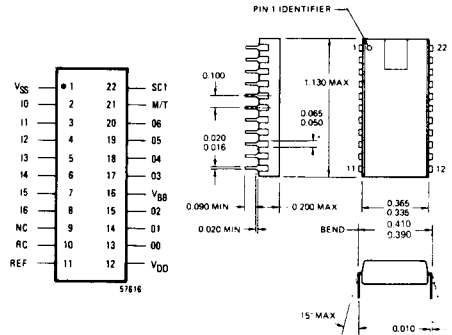


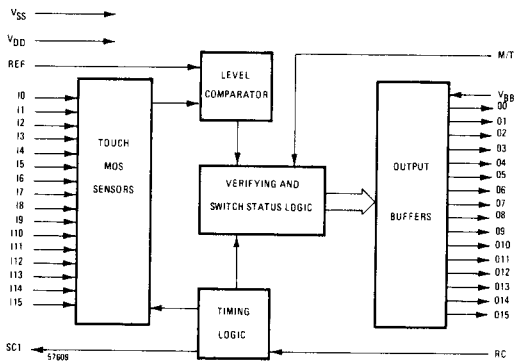
### TOUCHCONTROL INTERFACE



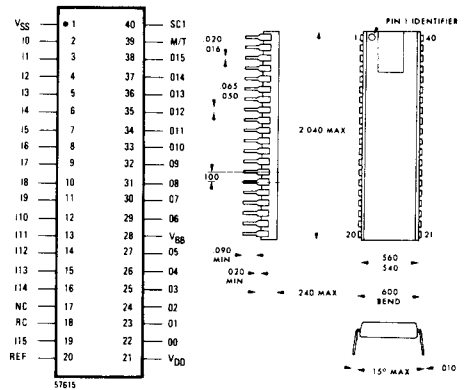
**BLOCK DIAGRAM – S9260/S9261 (7 SWITCHES)**



**PIN/PACKAGE CONFIGURATION  
S9260/S9261**



**BLOCK DIAGRAM – S9263/S9264/S9265 (16 SWITCHES)**



**PIN/PACKAGE CONFIGURATION  
S9263/S9264/S9265**

### FEATURES

- Interfaces with up to 16 touch switches
- Eliminates contact noise
- Comparator sensing permits use with wide variety of touch switch configurations
- Momentary or toggle operation electrically selectable
- Outputs are TTL/CMOS/MOS compatible
- Simplifies design of touch-sensitive switches



### GENERAL DESCRIPTION

The S9260 series of MOS TouchControl interface circuits permits almost any control panel containing mechanical switches to be easily replaced by a flat-surface capacitive control panel providing superior styling, reliability, ease of cleaning, and safety. Connecting directly to a screened or etched pattern on the panel's reverse side, these MOS circuits provide outputs to drive a variety of logic systems from household appliances to industrial controls. All system functions are then selected by merely touching the flat conductive TouchControl "switch" areas that have been deposited on the panel's front surface in practically any configuration desired.

These circuits provide an individual output for each of up to 16 TouchControl switches. For applications requiring more switches or encoded outputs, refer to AMI's S9262 and S9266, which can interface with up to 32 switches.

### FUNCTIONAL DESCRIPTION

Fabricated with P-channel ion implanted MOS/LSI technology, the S9260 family\* of TouchControl integrated circuits has been designed to interface with a variety of touch panel switches and provide a high degree of flexibility in the selection of touch panel materials, layout of touch pad configurations, and design of switching functions. These circuits can interface directly with either seven TouchControl switches (22 lead versions) or sixteen TouchControl switches (40 lead ver-

sions). For each TouchControl switch input there is a corresponding output that may be used to interface with various logic families such as CMOS or TTL.

Both momentary and "push on - push off" (toggle) switching operations are available on all AMI TouchControl circuits and are electrically selected by the logic levels of one input pin. To ensure reliable switch action, a built-in delay is incorporated in all circuits requiring a minimum touch time for switch response.

### TYPICAL APPLICATIONS

- |   |  |  |
|---|--|--|
| <ul style="list-style-type: none"> <li>● Appliance Control Panels</li> <li>● Home Entertainment Systems</li> <li>● Power Tool Controls</li> <li>● Televisions</li> <li>● Automotive Controls</li> </ul> | <ul style="list-style-type: none"> <li>● Telephones</li> <li>● Games</li> <li>● Fast Food Waterproof Keyboards</li> <li>● Moisture Proofing</li> <li>● Industrial Controllers</li> <li>● Computer Terminals</li> </ul> | <ul style="list-style-type: none"> <li>● Keyboards</li> <li>● Instrumentation</li> <li>● 16 to 1 Multiplexers</li> <li>● Microprocessor Interface</li> <li>● Vending Machines</li> <li>● Cash Registers</li> </ul> |
|---|--|--|

### ABSOLUTE MAXIMUM RATINGS

Voltage on any pin relative to $V_{SS}$ :	+ 0.3V to - 20V	Storage temperature (Ambient)	- 65°C to + 150°C
Operating temperature range:	0°C to + 70°C		

\*FOR MULTIPLEXED TOUCHCONTROL CIRCUITS SEE AMI S9262 and S9266.

### ELECTRICAL CHARACTERISTICS

(0°C < T<sub>A</sub> < 70°C; V<sub>SS</sub> = 0V; V<sub>DD</sub> = - 13.5V to - 18.0V unless otherwise specified.)

SYMBOL	PARAMETER	MIN	TYP	MAX	UNITS	CONDITIONS
V <sub>IL</sub>	Input logic 0 level – all except “I” inputs.	+ 0.3	0	- 1.5	Volts	Note: M/T input is internally pulled up to V <sub>SS</sub>
V <sub>IH</sub>	Input logic 1 level – all except “I” inputs	- 10.0	- 12.0	- 18.0	Volts	
f <sub>RC</sub>	Internal oscillator frequency measured at RC input.	50		100	kHz	
T <sub>S</sub>	Switch delay time	65		135	msec	Frequency measured at RC Input = 50 kHz
T <sub>RST</sub>	Time to reset all latches using M/T input.		100	135	msec	
V <sub>OL</sub>	Output low voltage	V <sub>SS</sub>		- 1.0	Volts	V <sub>BB</sub> = V <sub>SS</sub> ; 10K resistive load to V <sub>DD</sub>
V <sub>OH</sub>	Output high voltage			V <sub>DD</sub>		
V <sub>OL</sub>	Output low voltage	V <sub>SS</sub>		V <sub>SS</sub> - 0.5	Volts	V <sub>SS</sub> = +5V; V <sub>BB</sub> = 0V V <sub>DD</sub> = 12V; 2800Ω resistive load to V <sub>SS</sub>
V <sub>OH</sub>	Output high voltage	V <sub>BB</sub> + 0.4		V <sub>BB</sub>		
SC1	Scan clock output: Output low voltage Output high voltage	V <sub>SS</sub>		- 1.5 V <sub>DD</sub>		Max. capacitive loading < 150 pF
I <sub>DD</sub>	Supply Current		7.0	15.0	ma	Outputs unconnected

### OPERATION

Device operation can be understood by referring to Figure 1, depicting a typical application of the S9263. Each of the sixteen pairs of series capacitors labeled S1 – S16 is one touch switch located on a TouchControl panel. (For details on touch panel configuration and operation, see the TouchControl application note included in this APD.) In each capacitor pair, the two common plates represent the conductive area on the control panel surface that is to be touched. The other two plates are formed by two conductive surfaces parallel to the touched surface and located directly under it on the reverse side of the panel. Referring again to Figure 1, the S9263 generates a clock signal on output SC1 that is applied to one plate of each capacitor pair; this signal passes through the two

series capacitors and is detected in the MOS circuit. When a panel switch surface is touched, the signal level into the chip diminishes, and the on-chip differential amplifier senses the change and performs the appropriate switching function. For example, if surface S1 is touched, the signal at input I3 decreases, and output O3, normally open, now becomes active and drives the S1 input to the TTL circuitry toward voltage level V<sub>BB</sub>.

### I INPUTS

Inputs from the touch switch pads to the TouchControl circuit are labeled I0 through I15 (S9263, S9264, and S9265) or I0 through I6 (S9260 and S9261). Each I input relates directly to an O output of identical numeral.

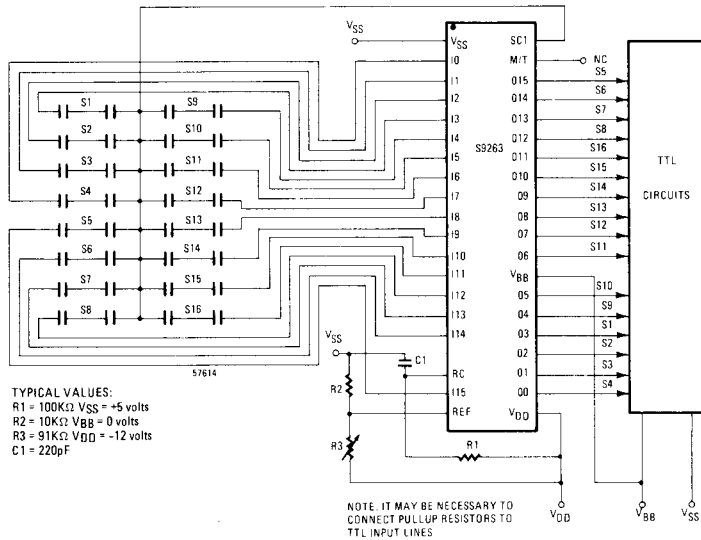


FIGURE 1. 16 SWITCH APPLICATION USING S9263

### RC INPUT

A resistor connected to  $V_{DD}$  and a capacitor connected to  $V_{SS}$  are connected to the RC input pin to establish the on-chip clock frequency that controls the touch switch delay time. Nominal values for these components are suggested in Figure 1, but they may be varied to change clock frequency over a range of 50 kHz to 100 kHz.

### REF INPUT

In order to allow flexibility in the choice of Touch-Control panel materials, switch layout, and switch size, AMI Touch Control inputs have been designed to detect a differential change rather than an absolute change in level. To obtain a reference level, two resistors are connected to input REF, one to  $V_{SS}$  and the other to  $V_{DD}$ .

### O OUTPUTS

Each output pin labeled "O" corresponds to an input pin labeled "1." Whenever an input is selected, the output becomes active and will drive an external load toward supply voltage  $V_{BB}$ . When outputs are not active, they are high impedance open drain.

### $V_{BB}$ SUPPLY

The sources of all output devices are common and connected to pin  $V_{BB}$ . This allows TTL compatibility as shown in Figure 1, as well as the ability to drive higher level signals. For instance, if  $V_{SS} = 0$  volts,  $V_{DD} = -16$  volts, and  $V_{BB} = V_{SS}$ , then active outputs would drive a load connected to  $V_{DD}$  towards  $V_{SS}$ . The  $V_{BB}$  pin can be used also to switch analog signals; in this configuration the analog signals are applied to the "O" pins and  $V_{BB}$  is the output pin.

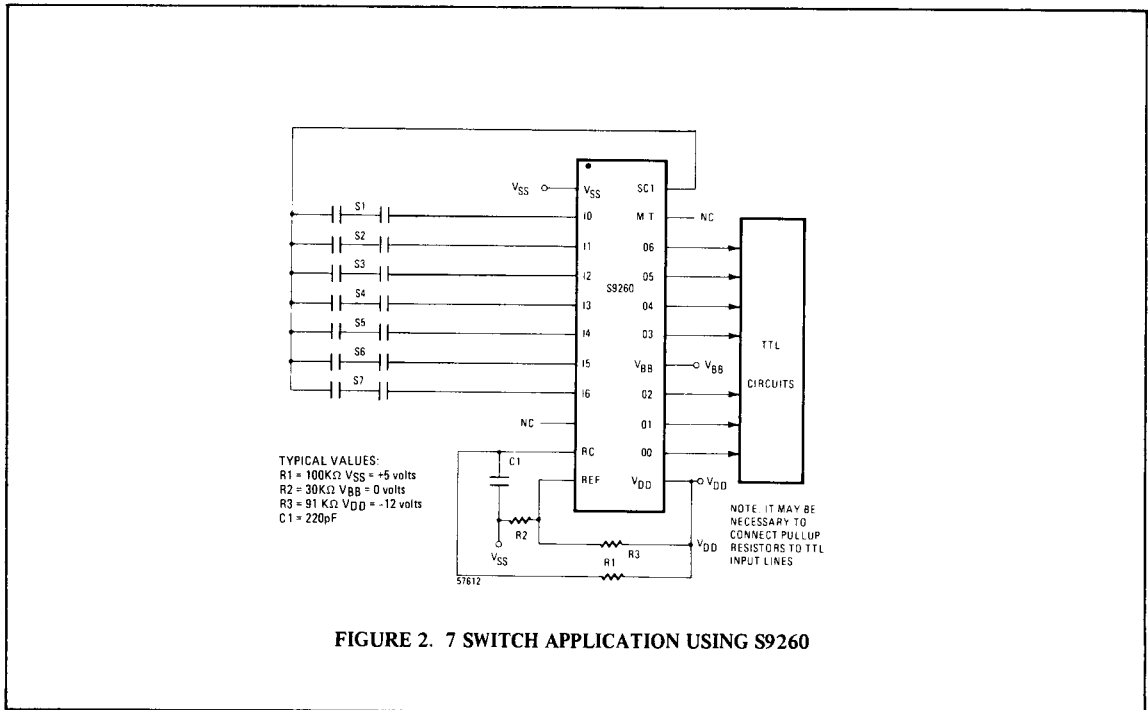


FIGURE 2. 7 SWITCH APPLICATION USING S9260

### M/T INPUT

The M/T input pin selects the mode of switch operation, either momentary or toggle. With no connection to the M/T pin momentary operation is selected, and appropriate outputs are active only for the duration of touching a switch. In this mode, no output is active when no switch is touched. A V<sub>DD</sub>

level applied to M/T causes the circuit to operate in the toggle mode. In this condition, the brief touch of any switch will turn on the appropriate output, which will remain latched on until the switch is touched again. Subsequent activations of the switch will toggle the corresponding output on and off alternately. To reset all outputs when the toggle mode is selected, a pulse of V<sub>SS</sub> level may be applied to the M/T input.

### SCI OUTPUT

The SC1 output provides the clock signal for the Touch-Control panel. Its frequency is determined by the RC time con-

stant, and it is connected in common with one of each of the two common conductive surfaces on the reverse side of the touch panel.

### MOMENTARY AND TOGGLE COMBINATION

The S9261, S9264, and S9265 contain several outputs that are permanently in the momentary mode of operation.

With the M/T input at V<sub>SS</sub> these parts function identically to the S9260 and S9263. With M/T at a logic 1 level, however, the S9261 has four momentary and three toggle inputs. Table 1 shows the combinations available on all three parts.

TABLE 1. COMPARISON OF FEATURES

Part Number	Pin Count	Touch Switch Capacity			Number of Outputs
		Total Touch Switch Interface Capability	Touch Inputs Selectable For Either Momentary Or Toggle Operation Through Use of M/T Input	Touch Switch Inputs Fixed In Momentary Operation (Not affected by state of M/T input)	
S9260	22	7	7	0	7
S9261	22	7	3 (I4 thru I6)	4 (I0 thru I3)	7
S9263	40	16	16	0	16
S9264	40	16	8 (I8 thru I15)	8 (I0 thru I7)	16
S9265	40	16	12 (I4 thru I15)	4 (I0 thru I3)	16

CONSUMER

### TOUCHCONTROL APPLICATION NOTES

#### PANEL CONSTRUCTION

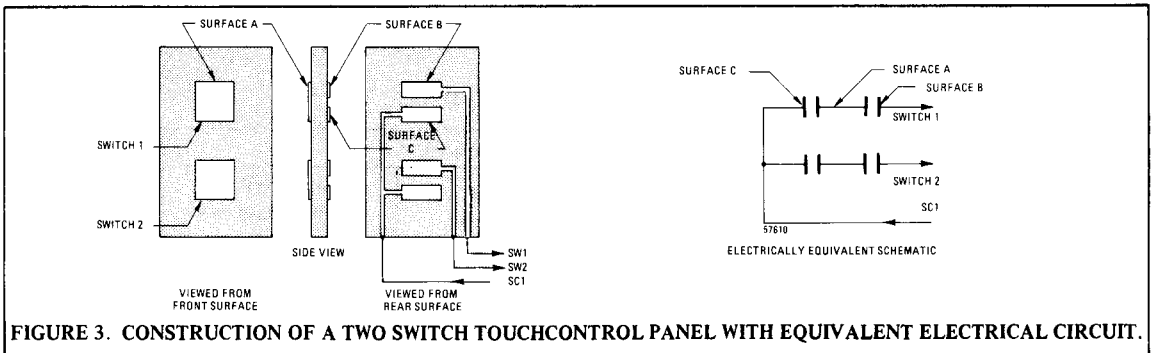
A TouchControl switch panel consists of a single sheet of a rigid material with conductive surfaces applied on both sides as shown in Figure 3.

A number of materials may be used for touch panels, the selection of the material most suited for a particular application being dependent on such things as durability, appearance, ease of assembly, cost, and dielectric constant of the material.

Regardless of the selected panel material, a touch switch is formed by applying a single conductive surface to its front surface with two other conductive surfaces applied directly in line on the reverse side of the panel. Figure 3 shows three views of a typical touch panel containing two TouchControl switches. On switch one, conductive surface A is applied to the front of

the panel and is the surface to be touched to effect a switch closure. Surfaces B and C are applied directly in line with A on the opposite side of the panel. A should cover completely and may overlap surfaces B and C.

The application of the conductive surfaces depends on selection of the panel materials. If glass is used, for example, it is common to apply a coating of tin oxide, which is then fired on for durability; rear surface conductors may be screened on with a conductive ink. Touch panels may be made more simply from double-sided printed circuit boards in which the conductive TouchControl surfaces are created by standard etching. For breadboarding purposes, a number of conductive tapes and paints are available and may be applied to a variety of touch panel materials.



**FIGURE 3. CONSTRUCTION OF A TWO SWITCH TOUCHCONTROL PANEL WITH EQUIVALENT ELECTRICAL CIRCUIT.**

### ELECTRICAL OPERATION

The three conductive surfaces in a TouchControl switch combine to form two capacitors connected in series, as shown in the schematic diagram of Figure 3. An AC signal generated in the MOS circuit is applied to the rear conductive surface labeled C. This signal is coupled through to surface A by the capacitor formed by C and A. The signal is then coupled to surface B by the capacitor formed by A and B and applied to one of the inputs of the MOS circuit, which detects the signal's presence. When surface A is touched, the amplitude of the signal is significantly decreased because of body capacitance. This is sensed by the MOS circuit, and the appropriate switching function is performed.

### TOUCH SWITCH LAYOUT GUIDELINES

AMI TouchControl circuits have been designed to interface with a variety of touch switch configurations. However, there are several guidelines that must be observed to insure a satisfactory TouchControl system.

The size of a TouchControl switch is dependent on the amount of capacitance needed to couple the clock signal to the "I" inputs of the MOS circuits. Because the input capacitance associated with the circuit input is typically five picofarads, it is advisable that each of the two series capacitors formed by the three conductive TouchControl panel surfaces be no less than seven picofarads. Since the capacitance in picofarads can be calculated by  $C = 0.22\epsilon A / d$ , where  $\epsilon$  is the dielectric constant, A is area, and d is the material's thickness, it is apparent that minimum switch size is dependent on the thickness and dielectric constant of the panel material. If, for example, the panel is made from 1/8" thick glass with a dielectric constant of 8, then the minimum area of each of the two rear surface conductors is 0.5 sq. inches. Since the touch

surface must cover the entire area of the two rear conductors, it must, then, be at least 1.0 sq. inch. It is desirable to separate the two rear-surface conductors by at least 0.125 inches, so the touch surface would be somewhat larger than 1.0 sq. inch. Higher capacitance, and thus smaller touch switches, can be obtained by using epoxy printed circuit material; though the dielectric constant is lower (around 5.0) the thickness can be decreased substantially.

### CIRCUIT TO PANEL CONNECTIONS

There are a number of ways to make the necessary connections between TouchControl circuits and panels. A simple approach is to use a printed circuit board for the touch panel. In this case, the connections to the circuit are made by the etched copper pattern. In laying out a printed circuit, it is important to keep the copper traces running to the individual touch pads separated from each other as much as possible. In most instances a minimum spacing of 0.125" between traces is acceptable, though wider spacing might be necessary in cases where traces will run parallel to each other for distances of over six inches. It is also important to keep the clock output (SC1) at least 0.75 inches away from any input trace. These spacing requirements are guidelines to be followed regardless of the touch panel material.

With glass touch panels, a simple method for breadboarding systems is to fasten individual wires onto the conductive surfaces with a conductive epoxy. For production situations, it is possible to locate the electronic circuitry on a separate printed circuit board. Contact to the glass touch panel can be made through spring contacts mounted in the appropriate locations on the circuit board. An alternate approach is to route the traces on the glass to an edge of the glass, making connection through an edge connector, keeping in mind the spacing requirements between traces.