

**Monolithic** **MMI** **Memories**
**16-Bit  
Barrel Shifter Slice  
677530**

# ADVANCE INFORMATION

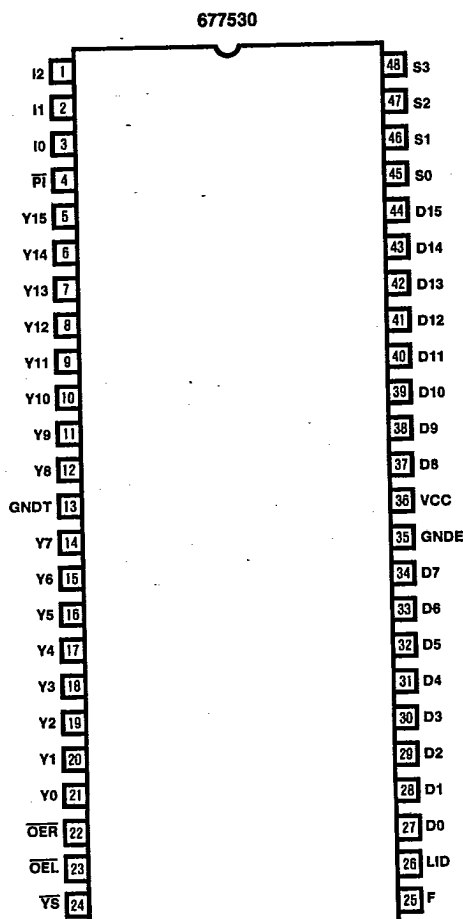
## Features/Benefits

- Left/Right shift and rotate to any position within 1 cycle
- Expandable to any multiples of 16-bit paths
- Works on sign magnitude and two's complement shift count inputs
- High speed operation:  
Data to output: 25 ns (max)  
Shift count to output: 30 ns (max)
- Sticky bit available for floating point rounding operation
- Bit Insert and bypass operations

## Packaging Information

PART NUMBER	PACKAGE	TEMPERATURE
677530	D48	Commercial

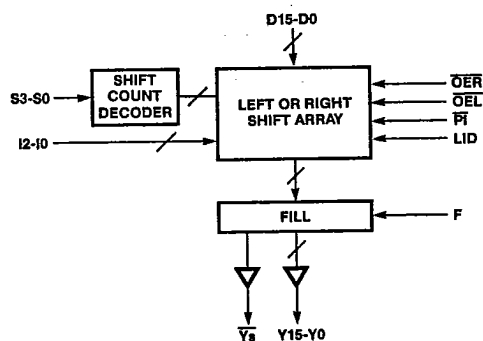
## Pin Configuration



## Applications

- Mantissa adjustment for floating point addition/subtraction and fixed point scaling in minicomputers, mainframes, array processors and digital signal processors
- Positioning non-numeric patterns in image processing, word processing and symbol processing systems
- Implement a funnel shifter for the Bit Block Transfer operation in graphics
- Implement a compression-expansion engine using the modified Huffman coding method
- Bit Insertion for EDAC applications

## Block Diagram



16-Bit Barrel Shifter Slice

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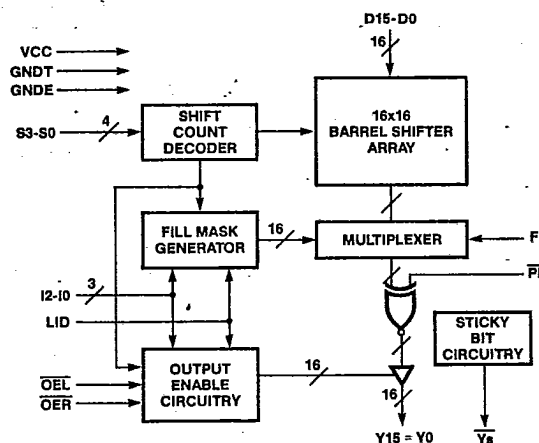


Figure 1. Internal Organization of the '7530 Barrel Shifter Slice

### Description

The '7530 16-Bit Barrel Shifter Slice is designed to be used as a general-purpose one-cycle shifter in numerical processing and symbol processing systems. The basic slice can handle data in 16-bit packets, shift and rotate to any desired number of positions within one cycle. They can also be cascaded together to form a barrel shifter function module with longer word length. Cascading shifter slices to form a functional module will not put additional delays into the datapath.

The '7530 can perform nine different operations. A 3-bit opcode (I2-I0) and the  $\overline{PI}$  (Polarity Insertion) input determines which function is to be performed. The shift count for the device is determined by the 4-bit input (S3-S0). The entire shifter is combinatorial with no internal states.

All data outputs (Y15-Y0) can be tristated. This output design is crucial to the cascading architecture because outputs from different barrel shifter slices will be tied together in an expanded array. The  $\overline{OER}$ ,  $\overline{OEL}$  (Output Enable Right/Left) and the LID (Location Identifier) input signals together determine the enable states of each individual output.

The F (Fill) input bit provides the signal to be inserted into the outputs.

The  $\overline{Ys}$  output (Sticky Bit) is provided as an open collector output. It is the negation of the logical OR of all the bits shifted out during the shift left or shift right operation.

The  $\overline{PI}$  (Polarity/Insertion) input is used to complement the outputs for all the opcodes except when I = 010 when it is used to distinguish between Bit Insert and BYPass operation.

## Architecture

As shown in Figure 1, the architecture of the '7530 Barrel Shifter Slice is centered around the internal barrel shifter array and the shift count decoder. The outputs of the array are fed into a mask generator which determines the enable states of each individual data outputs. These enable states are primarily determined by the LID (Location Identifier) input signal that represents the location of each shifter slice when they are cascaded. The Location Identifier will transform the actual operation of every shifter to make cascading possible. Please refer to the section *Cascading Architecture for the Barrel Shifter Slice* for a detailed description.

The output control circuitry consists of the polarity control, Fill bit insertion and Sticky Bit generation.

Two enable inputs, OEL and OER, provide the tristate control to the two portions of the output data separated by the left margin (D15) of the original input data.

## Signal Description

**D15-D0: Inputs.** Input data to the Barrel Shifter Slice.

**Y15-Y0: Outputs.** Output data from the Barrel Shifter Slice.

**I2-I0: Inputs.** A 3-bit opcode to select one of nine possible operations for the device. Please see Table 1 for further detail.

**S3-S0: Inputs.** Shift count input. For opcodes 00X or 11X (i.e., I2I1I0 = 0, 1, 6 or 7), S3-S0 represent the magnitude of bit positions shifted or rotated. For opcodes 10X (i.e., I2I1I0 = 4 or 5), the number of bits to be shifted or rotated is given by the two's complement of the five-digit number: I2S3S2S1S0. Since I2 = 1 in both cases, only sixteen different bit positions (ranging from +1 to +16) are allowed within one cycle. For the opcodes X01 (i.e., I2I1I0 = 1 or 5), the shift count inputs can be considered in two ways: either as a rotate right two's complement I2S3S2S1S0 operation or as a rotate left S3S2S1S0 operation when I2 = 0.

**PI: Input.** Polarity/Insertion signal input. This signal serves two purposes. When the opcode is 010 (i.e., I2I1I0 = 2), it is used to resolve between Bit Insert operation ( $\overline{PI} = 0$ ) and BYPass operation ( $\overline{PI} = 1$ ). When the opcode is in some other states, PI determines the output data polarity ( $\overline{PI} = 0$  for complemented data,  $\overline{PI} = 1$  for uncomplemented (true) data).

**F: Input.** Fill bit input. The value of this input is used to insert into positions left empty from shift operations, or insert into the designated bit positions for the Bit Insert and FILL operations.

**YS: Output.** The inverse of the sticky bit. This is an open collector output signal. Functionally this signal is the negation of the logical OR of the bits shifted out in the shift left/right operations. In the Bit Insertion operation, YS is the negation of the input bit that is replaced by the Fill bit.

**LID: Input.** Location Identifier. The input to this pin can either be VCC, ground, or left open. In the case when the input is open, there is an internal resistor network to divide this signal to 2.5 V ( $V_{CC}/2$ ). The LID signal is used in the expansion scheme of the barrel shifter slices. Different barrel shifter slices can be cascaded in a two-dimensional array to form a barrel shifter module of wider path width. The LID input signal is required to be one of the above three states according to its position inside the array.

**OEL, OER: Inputs.** Output enable left and output enable right. These two signals will separately enable the left and the right halves of the output data separated by the left margin (D15) of the input word.

**GNDE, GNDT: Power supply grounds.** GNDE is the internal ECL circuit ground and GNDT is the internal TTL circuit ground. These two ground signals should be routed separately in the system. The ECL ground is more sensitive to noise problems and should be bypassed with capacitive components to VCC.

**VCC: Power supply.** A +5 V power supply to the internal circuit of the Barrel Shifter Slice.

## Function Tables

OPCODE			POLARITY/ INSERT	OPERATION PERFORMED IF LID PIN IS "OPEN"		OUTPUT POLARITY	ALTERNATE OPERATION	
$I_2$	$I_1$	$I_0$		MN.	NAME		LID = VCC	LID = GND
0	0	0	0 1	LSH	Left SHift	Complemented True	LRT	FIL
0	0	1	0 1	LRT	Left RoTate	Complemented True	LRT	LRT
0	1	0	0 1	BIT BYP	Bit InserT BYPass	True True	High Z High Z	High Z High Z
0	1	1	0 1	FIL	FILL	Complemented True	High Z High Z	High Z High Z
1	0	0	0 1	RSC	Right Shift with two's— Complement shift count	Complemented True	FIL	RRC
1	0	1	0 1	RRC	Right Rotate with two's— Complement rotate count	Complemented True	RRC	RRC
1	1	0	0 1	RSH	Right SHift	Complemented True	FIL	RRT
1	1	1	0 1	RRT	Right RoTate	Complemented True	RRT	RRT

Figure 1. Shifter Instruction Set

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