

# SN54S482, SN74S482 4-BIT-SLICE EXPANDABLE CONTROL ELEMENTS

SDLS212

D2112, MARCH 1976—REVISED OCTOBER 1980

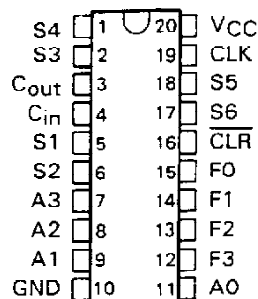
- 4-Bit Slice is Cascadable to N-Bits
- Designed Specifically for Microcontroller/Next-Address Generator Functions
- Increment/Decrement by One (Immediate or Direct Symbolic Addressing Modes)
- Offset, Vector, or Branch (Indexed or Relative Addressing Modes)
- Store Up to Four Returns or Links (Program Return Address from Subroutine)
- Program start or Initialize (Return to Zero or Clear Mode)
- On-Chip Edge-Triggered Output Register (Provides Steady-State Micro-Address/Instruction)
- High-Density 20-Pin Dual-in-Line Package with 300-Mil Row Pin Spacing

## description

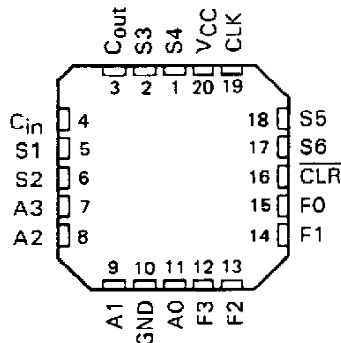
The 'S482 is a high-performance Schottky TTL 4-bit-slice control element for use in any computer/control application requiring the coupling of high-performance bipolar speeds with the flexibility of microprogram control and bit-slice expandability. When used as a next-address generator, two 'S482 elements can address up to 256 words of microprogram; three elements can address up to 4096 words of microprogram; or a number of 'S482 elements can generate N words in multiples of four lines.

Comprised of an output register, push-pop stack, and a full adder, the 'S482 provides the capability to implement multiway testing needed to generate or to determine and select the source of the next function of microprogram address.

SN54S482 . . . J PACKAGE  
SN74S482 . . . J OR N PACKAGE  
(TOP VIEW)



SN54S482 . . . FH PACKAGE  
SN74S482 . . . FN PACKAGE  
(TOP VIEW)



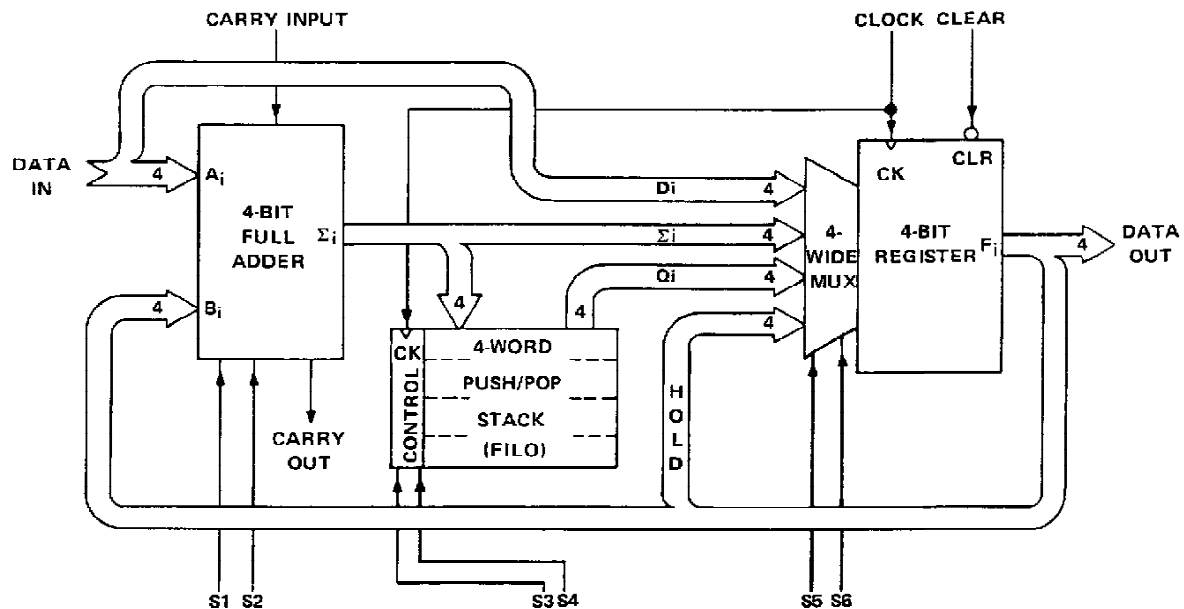
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## 4-BIT-SLICE EXPANDABLE CONTROL ELEMENTS

### functional block diagram



### output register and source functions

The 4-bit edge-triggered register provides a steady-state output throughout each system clock cycle. An asynchronous clear extends the multiway testing to directly implement system initialization at ROM address zero.

Two source-select lines (S5, S6) provide the output register with access to either the current instruction (no change), an operand or address stored in the push-pop stack, the output of a four-function full adder, or a direct data-in address port. The sources and functions are summarized in Table I and II.

In bus applications, provision must be made to control negative spikes. When low, the output latches can be disturbed if the outputs are forced more negative than  $-0.5$  V.

TABLE I. REGISTER-SOURCE FUNCTIONS

SELECT		REGISTER INPUT SOURCE
S5	S6	
L	L	DATA-IN PORT (D <sub>i</sub> )
L	H	FULL ADDER OUTPUTS (Σ <sub>i</sub> )
H	L	PUSH-POP STACK OUTPUTS (Q <sub>i</sub> )
H	H	REGISTER OUTPUTS (HOLD)

H = high level, L = low level

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TABLE II. PUSH-POP STACK CONTROL AND REGISTER-SOURCE FUNCTIONS

	INPUTS						INTERNAL	OUTPUTS
	S3	S4	S5	S6	CLOCK	CLEAR	Q <sub>i</sub> A	F <sub>i</sub>
HOLD	X	X	X	X	L	H	Q <sub>i</sub> A0	F <sub>i</sub> 0
CLEAR	X	X	X	X	X	L	Q <sub>i</sub> A0	L
PUSH-POP STACK "HOLD"	L	L	L	L	↑	H	Q <sub>i</sub> A0*	D <sub>i</sub>
	L	L	L	H	↑	H	Q <sub>i</sub> A0*	Σ <sub>i</sub>
	L	L	H	L	↑	H	Q <sub>i</sub> A0*	Q <sub>i</sub> A0
	L	L	H	H	↑	H	Q <sub>i</sub> A0*	F <sub>i</sub> 0
PUSH-POP STACK "LOAD"	L	H	L	L	↑	H	Σ <sub>i</sub> *	D <sub>i</sub>
	L	H	L	H	↑	H	Σ <sub>i</sub> *	Σ <sub>i</sub>
	L	H	H	L	↑	H	Σ <sub>i</sub> *	Q <sub>i</sub> A0
	L	H	H	H	↑	H	Σ <sub>i</sub> *	F <sub>i</sub> 0
PUSH-POP STACK "POP"	H	L	L	L	↑	H	Q <sub>i</sub> B0 <sup>†</sup>	D <sub>i</sub>
	H	L	L	H	↑	H	Q <sub>i</sub> B0 <sup>†</sup>	Σ <sub>i</sub>
	H	L	H	L	↑	H	Q <sub>i</sub> B0 <sup>†</sup>	Q <sub>i</sub> A0
	H	L	H	H	↑	H	Q <sub>i</sub> B0 <sup>†</sup>	F <sub>i</sub> 0
PUSH-POP STACK "PUSH"	H	H	L	L	↑	H	Σ <sub>i</sub> <sup>‡</sup>	D <sub>i</sub>
	H	H	L	H	↑	H	Σ <sub>i</sub> <sup>‡</sup>	Σ <sub>i</sub>
	H	H	H	L	↑	H	Σ <sub>i</sub> <sup>‡</sup>	Q <sub>i</sub> A0
	H	H	H	H	↑	H	Σ <sub>i</sub> <sup>‡</sup>	F <sub>i</sub> 0

MSB                      LSB  
i = 3, 2, 1, 0  
A<sub>i</sub> = Data inputs  
Q<sub>i</sub>A = Push-pop stack word A output (internal)  
Q<sub>i</sub>A0 = the level of Q<sub>i</sub> before the indicated inputs conditions were established.

F<sub>i</sub> = Device outputs  
F<sub>i</sub>0 = the level of F<sub>i</sub> before the indicated input conditions were established  
Σ<sub>i</sub> = Adder outputs (internal)  
\*Q<sub>i</sub>B, Q<sub>i</sub>C, Q<sub>i</sub>D do not change  
†Q<sub>i</sub>D0 → Q<sub>i</sub>D, Q<sub>i</sub>D0 → Q<sub>i</sub>C, Q<sub>i</sub>C0 → Q<sub>i</sub>B, Q<sub>i</sub>B0 → Q<sub>i</sub>A  
‡Q<sub>i</sub>A0 → Q<sub>i</sub>B, Q<sub>i</sub>B0 → Q<sub>i</sub>C, Q<sub>i</sub>C0 → Q<sub>i</sub>D

### push-pop stack control

The 4-word push-pop stack can be used for nesting up to four levels of program or return (link) addresses. In the load mode, the first (top) word is filled with new data from the output of the full adder, and no push occurs meaning that previous data at that location is lost. However, all other word locations in the push-pop stack remain unchanged. In the push mode, the new word is again entered in the first (top) location; however, previous data residing in the top three words are pushed down one word location and retained at their new locations. The bottom word is written over and lost.

In the pop mode, words in the push-pop stack move up one location on each clock transition. A unique function is provided by the bottom (fourth) register as its content is retained during the pop mode, and after 3 clock transitions, all words in the stack are filled with the operand/address that occupied the bottom register.

The operand/address will remain available indefinitely if stack functions are limited to the pop or hold modes.

The push-pop stack functions are shown in Tables II and III.



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TABLE III. PUSH-POP STACK FUNCTIONS

	FUNCTION	SEL.		REG. D	REG. C	REG. B	REG. A	INPUT/ OUTPUT
		S3	S4					
BIT 0	LOAD	L	H	Q <sub>i</sub> D0	Q <sub>i</sub> C0	Q <sub>i</sub> B0	← Σ <sub>i</sub>	Σ <sub>i</sub> IN
BIT 1	PUSH	H	H	← Q <sub>i</sub> C0	← Q <sub>i</sub> B0	← Q <sub>i</sub> A0	← Σ <sub>i</sub>	Σ <sub>i</sub> IN
BIT 2	POP	H	L	↺ Q <sub>i</sub> D0	→ Q <sub>i</sub> D0	→ Q <sub>i</sub> C0	→ Q <sub>i</sub> B0	Q <sub>i</sub> A OUT
BIT 3	HOLD	L	L	Q <sub>i</sub> D0	Q <sub>i</sub> C0	Q <sub>i</sub> B0	Q <sub>i</sub> A0	Q <sub>i</sub> A OUT

μlink operations show previous data location after clock transition.

### full adder

The four-function full adder is controllable from select inputs S1 and S2 to perform:

- A or B incrementation, or decrementation of B
- Unconditional jumps or relative offsets
- No change
- Return to zero or one

Incrementation can be implemented by forcing a carry (high) into the ALU. In this mode either of the following options are possible:

1. Increment (A plus zero plus carry)
2. Increment B (zero plus B plus carry), or decrement B (all highs at A then A plus B with carry input low and disregard, don't use, carry out)
3. Increment the jump or offset (A plus B plus carry)
4. Start at zero or one and increment on each clock (select zero plus zero plus carry, then select zero plus B plus carry), or set register to N and decrement B (see 2 above).
5. No change (carry input is always active and removal of carry combined with either the ALU or register hold mode will retain the current address).

Unconditional jumps can be implemented by applying and selecting the jump directly from the data inputs to the output register. Offset can be accomplished by summing the output register with the offset magnitude (A plus B) with carry low.

The ALU functions are shown in Table IV.

TABLE IV. ADDRESS CONTROL FUNCTIONS

INPUTS		INTERNAL Σ <sub>i</sub>
S1	S2	
H	H	0 PLUS 0 PLUS C-in
H	L	0 PLUS B <sub>i</sub> PLUS C-in
L	H	A <sub>i</sub> PLUS 0 PLUS C-in
L	L	A <sub>i</sub> PLUS B <sub>i</sub> PLUS c-in

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## 4-BIT-SLICE EXPANDABLE CONTROL ELEMENTS

### compound generator functions

As the function-select lines of the register sources, push-pop stack, and adder are independent, compound functions can be selected to occur on the next clock transition.

Subroutine branches and returns can be simplified by saving the return or link addresses in the push-pop stack. This branch-and-save function can be accomplished on the same clock time as follows:

DATA-IN	ADDER	PUSH-POP STACK	REGISTER SOURCE
Branch address	Zero plus B plus one (S1 = H, S2 = L)	Push (S3 = S4 = H)	Data-in (S5 = S6 = L)

Up to four branches can be made with the return stored in the 4-word push-pop stack.

### absolute maximum ratings over operating free-air temperature (unless otherwise noted)

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Input voltage	5.5 V
Off-state output voltage	5.5 V
Operating free-air temperature range: SN54S482	–55°C to 125°C
SN74S482	0°C to 70°C
Storage temperature range	–65°C to 150°C

NOTE 1. All voltage values are with respect to network ground terminal.

### recommended operating conditions

			SN54S482			SN74S482			UNIT
			MIN	NOM	MAX	MIN	NOM	MAX	
V <sub>CC</sub>	Supply voltage		4.5	5	5.5	4.75	5	5.25	V
V <sub>IH</sub>	High-level input voltage		2			2			V
V <sub>IL</sub>	Low-level input voltage				0.8			0.8	V
I <sub>OH</sub>	High-level output current	C <sub>out</sub>			− 1			− 1	mA
		Any F			− 2			− 2	
I <sub>OL</sub>	Low-level output current	C <sub>out</sub>			10			10	mA
		Any F			16			16	
t <sub>w</sub>	Pulse duration	CLK high or low	50		30				ns
		CLR low	15		15				
t <sub>su</sub>	Setup time, before CLK↑	Data-in, S5, S6	0		0				ns
		Data-in via adder to stack	35		30				
		Data-in via adder to output latch	25		20				
		S1, S2	40		30				
		S3, S4	20		15				
		CLR, inactive state	0		0				
t <sub>r</sub>	CLK input rise time		20		25			ns	
t <sub>h</sub>	Hold time, after CLK↑	Data-in, S5, S6	30		25			ns	
		Data-in via adder	15		10				
		S1, S2	15		10				
		S3, S4	25		20				
T <sub>A</sub>	Operating free-air temperature		− 55	125		0	70	°C	



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# **SN54S482, SN74S482** **4-BIT-SLICE EXPANDABLE CONTROL ELEMENTS**

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	SN54S482			SN74S482			UNIT
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
$V_{IK}$		$V_{CC} = \text{MIN.}$ , $I_L = -18 \text{ mA}$			-1.2			-1.2	V
$V_{OH}$	$C_{out}$	$V_{CC} = \text{MIN.}$ , $I_{OH} = -1 \text{ mA}$	2.5	3.4		2.7	3.4		V
	Any F	$V_{CC} = \text{MIN.}$ , $I_{OH} = -2 \text{ mA}$	2.5	3.4		2.7	3.4		
$V_{OL}$	$C_{out}$	$V_{CC} = \text{MIN.}$ , $I_{OL} = 10 \text{ mA}$			0.5			0.5	V
	Any F	$V_{CC} = \text{MIN.}$ , $I_{OL} = 16 \text{ mA}$			0.5			0.5	
$I_I$		$V_{CC} = \text{MIN.}$ , $V_I = 5.5 \text{ V}$			1			1	mA
$I_{IH}$	S1, S2, $C_{in}$	$V_{CC} = \text{MAX.}$ , $V_I = 2.7 \text{ V}$			50			50	$\mu\text{A}$
	S3, S4, S5, S6, CLK				0.1			0.1	mA
	CLR				0.25			0.25	
	Any A				0.15			0.15	
$I_{IL}$	S1, S2	$V_{CC} = \text{MAX.}$ , $V_I = 0.5 \text{ V}$			-1			-1	mA
	$C_{in}$				-0.8			-0.8	
	S3, S4				-1.2			-1.2	
	Any A, S5, S6				-2			-2	
	CLR				-4			-4	
	CLK				-2.8			-2.8	
$I_{OS}^{\S}$		$V_{CC} = \text{MAX}$	-40		-110	-40		-110	mA
$I_{CC}$		$V_{CC} = \text{MAX}$		90	130		90	140	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡All typical values are at  $V_{CC} = 5 \text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

§Not more than one output should be shorted at a time.

## switching characteristics (see Note 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	VCC = MIN to MAX CL = 15 pF RL = 280 Ω TA = MIN to MAX						UNIT
			SN54S482			SN74S482			
			MIN	TYP‡	MAX	MIN	TYP‡	MAX	
tPLH	CLK	Any F	12	30		12	25		ns
tPHL			15	30		15	25		
tPHL	CLR	Any F	12	25		12	20		ns
tPLH	Cin	Cout	12	22		12	18		ns
tPHL			10	22		10	18		
tPLH	Any A	Cout	17	30		17	25		ns
tPHI			12	30		12	23		

‡All typical values are at  $V_{CC} = 5 \text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

NOTE 1: See General Information Section for load circuit and voltage waveforms.

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