Application Note 522
Replacement for the MC146818A

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OVERVIEW

The Motorola MC146818A is no longer in production. There is no direct replacement for this part. However, systems that have been designed to use the MC146818A can be modified to operate with the Dallas Semiconductor DS12885, DS12887, DS1685, or DS1687. This application note discusses the differences between these parts and potential issues in converting from the MC146818A to the Dallas Semiconductor Real Time Clocks.

DESCRIPTION

The MC146818A provided clock and calendar functions with 50 bytes of user RAM memory, and was designed to work with either the Motorola or Intel processor timing. These features could be made nonvolatile by providing a backup battery on the board to maintain the V_{DD} supply. For timekeeping, the MC146818A required a number of discrete components on the PCB along with a crystal to provide an input frequency. The input frequencies could be 32.768 kHz, 1.048576 MHz, or 4.194304 MHz.

The DS12885 is designed to provide the same timekeeping functions with a total of 114 bytes of user NV RAM. To reduce the part count on the PCB, the DS12885 will accept direct connection of a 32.768 kHz crystal with no additional timing components required. The DS12885 also has a separate input for a backup battery with internal switching circuitry to avoid data corruption during a power fail condition. The DS12885 is available in either 24-pin DIP or 28-pin PLCC packages.

The DS1685 includes an enhanced feature set including: century byte; 64-bit serial number; wake-up alarm; kickstart; SMI recovery stack; 242 bytes of user NV RAM; and an auxiliary battery input. The timekeeping algorithm in the DS1685 includes leap year compensation valid up to 2100. The DS1685 is available in either 24-pin DIP or 28-pin PLCC packages.

The DS12887 and DS1687 are modules combining a RTC with a battery and crystal contained within the package, so that no external parts are required. The DS12887 includes the DS12885 while the DS1687 is built using the DS1685. The modules has the same foot print as the 600-mil DIP package, and can therefore be placed on existing boards with a minimum of board level changes required.

If replacing the MC146818A using an existing 600-mil DIP footprint is desired, then the DS12887 or DS1687 would be the preferred choice. This conversion will involve the least number of changes to the board and will work without removing the existing timing circuitry from the board. Using the DS12885 or DS1685 will require replacing the timing circuitry with a 32.768 kHz crystal attached directly to the crystal input pins. In order to make the DS12885 or DS1685 nonvolatile will also require the connection of a 3-volt battery directly to pins that have other functions on the MC146818A.

PIN COMPATIBILITY

There are some pin differences between the parts. Some of these may be addressed with software, while others may require PCB changes. Tables 1 and 2 gives the pin functions for the MC146818A, DS12885, DS1685, DS12887, and DS1687 in 600-mil DIP and PLCC packages respectively.

Note:

The DS1687 and DS12887 are not available in PLCC packages.

PIN NAMES - Table 1

Pin Number		MC146818A	DS12885	DS1685	DS12887	DS1687
24-Pin DIP	24-Pin PLCC					
1	2	MOT	MOT	$\overline{PWR}$	MOT	$\overline{PWR}$
2	3	OSC1	X1	X1	NC	NC
3	4	OSC2	X2	X2	NC	NC
4	5	AD0	AD0	AD0	AD0	AD0
5	6	AD1	AD1	AD1	AD1	AD1
6	7	AD2	AD2	AD2	AD2	AD2
7	8	AD3	AD3	AD3	AD3	AD3
8	9	AD4	AD4	AD4	AD4	AD4
9	10	AD5	AD5	AD5	AD5	AD5
10	12	AD6	AD6	AD6	AD6	AD6
11	14	AD7	AD7	AD7	AD7	AD7
12	15	V_{SS}	GND	GND	GND	GND
13	16	$\overline{CS}$	$\overline{CS}$	$\overline{CS}$	$\overline{CS}$	$\overline{CS}$
14	17	AS	AS	ALE	AS	ALE
15	19	R/$\overline{W}$	R/$\overline{W}$	$\overline{WR}$	R/$\overline{W}$	$\overline{WR}$
16	20	$\overline{STBY}$	Batt GND	Batt GND	NC	NC
17	21	DS	DS	$\overline{RD}$	DS	$\overline{RD}$
18	22	$\overline{RESET}$	$\overline{RESET}$	$\overline{KS}$	$\overline{RESET}$	$\overline{KS}$
19	23	$\overline{IRQ}$	$\overline{IRQ}$	$\overline{IRQ}$	$\overline{IRQ}$	$\overline{IRQ}$
20	24	CKFS	V_{BAT}	V_{BAT}	NC	NC
21	25	CKOUT	$\overline{RCLR}$	$\overline{RCLR}$	NC	$\overline{RCLR}$
22	26	PS	NC	V_{BAUX}	NC	V_{BAUX}
23	27	SQW	SQW	SQW	SQW	SQW
24	28	V_{DD}	V_{CC}	V_{CC}	V_{CC}	V_{CC}

FUNCTIONAL DIFFERENCES

Table 2 summarizes the functional changes by pin for the DS12885 and DS12887. Table 3 has the changes for the DS1685 and DS1687. These changes will need to be comprehended and the appropriate modifications made to the board in replacing the MC146818A with any of the Dallas Semiconductor parts. Any pins not listed in Tables 2 and 3 are "No Connects".

FUNCTIONAL DIFFERENCES - DS12885/87 - Table 2

Pin #				
DIP	PLCC	MC146818A	DS12885	DS12887
1	2	MOT	N/A	N/A
2	3	OSC1	The MC146818A required external components along with crystals of 32.768 kHz, 1.048576 MHz, or 4.194304 MHz. The DS12885 is designed to work with a 32.768 kHz crystal connected directly to pins 2 and 3.	The DS12887 does not require an external crystal, so any components on the board designed to connect a crystal to this pin may be removed. The MC146818A would accept input frequencies of 32.768 kHz, 1.048576 MHz, or 4.194304 MHz. The DS12887 includes a 32.768 kHz crystal in the module.
3	4	OSC2		
4	5	AD0	N/A	N/A
5	6	AD1	N/A	N/A
6	7	AD2	N/A	N/A
7	8	AD3	N/A	N/A
8	9	AD4	N/A	N/A
9	10	AD5	N/A	N/A
10	12	AD6	When accessing the clock memory, AD6 on the DS12885/87 needs to be low during the address strobe. It was a "don't care" on the MC146818A.	
11	14	AD7	N/A	N/A
12	15	V_{SS}	N/A	N/A
13	16	$\overline{CS}$	N/A	N/A
14	17	AS	N/A	N/A
15	19	R/$\overline{W}$	N/A	N/A
16	20	$\overline{STBY}$	The negative side of the backup battery needs to be connected to pin 16 of the DS12885. The DS12885 handles the switching to battery power internally and will disable reads and writes while in back backup mode.	This pin is a no connect on the DS12887. The DS12887 switches to an internal battery when V_{CC} is not present and automatically disables reads and writes.
17	21	DS	N/A	N/A
18	22	$\overline{RESET}$	N/A	N/A
19	23	$\overline{IRQ}$	N/A	N/A
20	24	CKFS	Pin 20 needs to be connected to the positive side of the backup battery.	No Connect
21	25	CKOUT	The user RAM will be cleared if this pin is taken low. There is an internal pull-up resistor, so this pin should be left floating and not tied high.	This pin is a no connect on the DS12887. On the DS12887A, the RCLR pin is brought out and should be treated the same as on the DS12885.
22	26	PS	The MC146818A used this pin to sense the battery voltage and set the VRT bit. This function is handled internally in the DS12885/87, and the pin is a no connect.	
23	27	SQW	N/A	N/A
24	28	V_{DD}	Any on board backup battery that was connected to pin 24 should be removed. The DS12885 is designed to have the backup battery connected to pins 16 and 20. The DS12887 has the backup battery included in the module.	

FUNCTIONAL DIFFERENCES - DS1685/87 - Table 3

Pin #				
DIP	PLCC	MC146818A	DS1685	DS1687
1	2	MOT	The $\overline{PWR}$ pin on the DS1685/87 is an output designed to support system power switching as a result of a date/time alarm (wake up) or a key closure (kickstart).	
2	3	OSC1	The MC146818A required external components along with crystals of 32.768 kHz, 1.048576 MHz, or 4.194304 MHz. The DS1685 is designed to work with a 32.768 kHz crystal connected directly to pins 2 and 3.	The DS1687 does not require an external crystal, so any components on the board designed to connect a crystal to this pin may be removed. The MC146818A would accept input frequencies of 32.768 kHz, 1.048576 MHz, or 4.194304 MHz. The DS1687 includes a 32.768 kHz crystal in the module.
3	4	OSC2		
4	5	AD0	N/A	N/A
5	6	AD1	N/A	N/A
6	7	AD2	N/A	N/A
7	8	AD3	N/A	N/A
8	9	AD4	N/A	N/A
9	10	AD5	N/A	N/A
10	12	AD6	When accessing the clock memory, AD6 on the DS1685/87 needs to be low during the address strobe. It was a "don't care" on the MC146818A.	
11	14	AD7	N/A	N/A
12	15	V_{SS}	N/A	N/A
13	16	$\overline{CS}$	N/A	N/A
14	17	AS	N/A	N/A
15	19	R/$\overline{W}$	N/A	N/A
16	20	$\overline{STBY}$	The negative side of the backup battery needs to be connected to pin 16 of the DS1685. The DS1685 handles the switching to battery power internally and will disable reads and writes while in back backup mode.	This pin is a no connect on the DS1687. The DS1687 switches to an internal battery when V_{CC} is not present and automatically disables reads and writes.
17	21	DS	N/A	N/A
18	22	$\overline{RESET}$	N/A	N/A
19	23	$\overline{IRQ}$	N/A	N/A
20	24	CKFS	This pin needs to be connected to the positive side of the backup battery.	No Connect
21	25	CKOUT	The user RAM will be cleared if this pin is taken low. There is an internal pull-up resistor, so this pin should be left floating and not tied high.	
22	26	PS	The MC146818A used this pin to sense the battery voltage and set the VRT bit. This function is handled internally in the DS1685/87. This pin is the positive side for an auxiliary battery required for the kickstart and wake-up features.	
23	27	SQW	N/A	N/A
24	28	V_{DD}	Any on board backup battery that was connected to V_{DD} should be removed. The DS1685 is designed to have the backup battery connected to pins 16 and 20 in the DIP and pins 20 and 24 in the PLCC. The DS1687 has the backup battery included in the module.	

REGISTER DIFFERENCES

The internal registers contained in memory locations 0A - 0D are used to control the timekeeping, calendar, and interrupt functions of these parts. In the MC146818A DV2 - DV0 were used to select the input frequency to provide a proper time base. Since the DS12885/87 and DS1685/87 use only the 32.768 kHz crystal these 3 bits are used to turn the oscillator on or off and to reset the countdown chain. A pattern of 010 is the only combination of bits that will turn the oscillator on and allow the RTC to keep time. A pattern of 11X will enable the oscillator but holds the countdown chain in reset. The next update will occur at 500 ms after a pattern of 010 is written to DV2 - DV0. The VRT bit is maintained internally in the DS12885/87 and DS1685/87 and will continuously indicate the state of the backup battery voltage. This bit is read only.

Table 4 contains a list of the registers and the differences that will need to be comprehended in converting to the DS12885, DS12887, DS1685, or DS1687.

INTERNAL REGISTERS - Table 4

				DS12885/87 and DS1685/87
Register A	MSB	7	UIP	N/A
		6	DV2	N/A
		5	DV1	1-Osc On; 0-Osc off
		4	DV0	Must be 0 for timekeeping
		3	RS3	N/A
		2	RS2	N/A
		1	RS1	N/A
	LSB	0	RS0	N/A
Register B	MSB	7	SET	N/A
		6	PIE	N/A
		5	AIE	N/A
		4	UIE	N/A
		3	SQWE	N/A
		2	DM	N/A
		1	24/12	N/A
	LSB	0	DSE	N/A
Register C	MSB	7	IRQF	N/A
		6	PF	N/A
		5	AF	N/A
		4	UF	N/A
		3	0	N/A
		2	0	N/A
		1	0	N/A
	LSB	0	0	N/A
Register D	MSB	7	VRT	This bit is read only and should always be 1 to indicate a good internal battery voltage.
		6	0	N/A
		5	0	N/A
		4	0	N/A
		3	0	N/A
		2	0	N/A
		1	0	N/A
	LSB	0	0	N/A