National Semiconductor

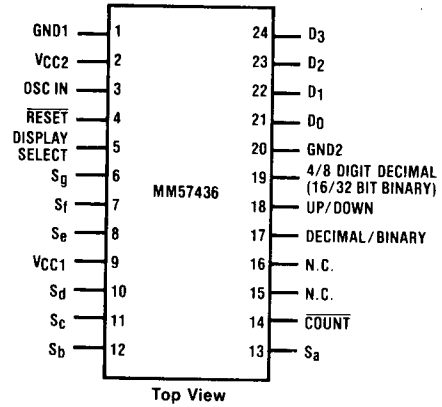
MM57436 Decimal/Binary Up/Down Counter

General Description

The MM57436 Counter, an NMOS silicon gate technology device, is designed to be a minimal solution Decimal/Binary Up/Down counter with display capability. The counter length is user selectable at 4 digits decimal (16 bits binary) or 8 digits decimal (32 bits binary). The device has the capability of direct drive of a 4 digit multiplexed LED display. In the 8-digit (32-bit) mode, the user may direct either the top four digits or lower four digits to the display. The MM57436 will run off an internal RC oscillator or the user may supply an external oscillator for greater precision in the count rate.

Features

- Decimal or binary count
- Up or down count
- 4 or 8 digit (16 or 32 bit) counter length
- 4 digit, seven segment multiplexed LED display drive
- User display control
- Single supply operation
- Wide supply range (4.5V-9.5V)
- TTL compatible on inputs



Top View

Order Number MM57436N
NS Package N24A

Pin	Description
OSC IN	Oscillator Input — External Oscillator or RC
Display Select	Control line to display upper or lower 4 digits (16 bits) of 8-digit (32-bit) counter
S_A-S_G	Multiplexed 7-segment outputs
$\overline{\text{COUNT}}$	Input for signal to be counted
Decimal/Binary	Counter mode control
Up/Down	Up-down count control
4/8 Digit (16/32 Bit Binary)	Counter length control
D_0-D_3	Display digit strobes
V_{CC1}, V_{CC2}	Power supply
GND1, GND2	Ground

Figure 1. Connection Diagram

Absolute Maximum Ratings

Voltage at Any Pin Relative to GND_1	−0.3V to +10V
Ambient Operating Temperature	0°C to +70°C
Ambient Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 10 Seconds)	300°C
Power Dissipation	0.75 Watt at 25°C
	0.4 Watt at 70°C

"Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. DC and AC electrical specifications are not ensured when operating the device at absolute maximum ratings.

DC Electrical Characteristics $0°C \leq T_A \leq 70°C$, $4.5V \leq V_{CC} \leq 9.5V$, unless otherwise specified

Parameter	Conditions	Min.	Typ.	Max.	Units
Operating Voltage (V_{CC})		4.5		9.5	V
Operating Supply Current	(all inputs and outputs open)			6.0	mA
Input Voltage Levels					
OSC IN, $\overline{RESET}$ Levels					
Logic High (V_{IH})		0.7 V_{CC}			V
Logic Low (V_{IL})				0.6	V
All Other Inputs					
Logic High (V_{IH})	$V_{CC} = 9.5V$	3.0			V
Logic High (V_{IH})	$V_{CC} = 5V \pm 10\%$	2.0			V
Logic Low (V_{IL})				0.8	V
Output Current Levels					
Output Sink Current					
D_0-D_3 (I_{OL})	$V_{CC} = 9.5V$, $V_{OL} = 1.0V$	30			mA
	$V_{CC} = 4.5V$, $V_{OL} = 1.0V$	15			mA
S_A-S_G (I_{OL})	$V_{CC} = 9.5V$, $V_{OL} = 0.4V$	0.8			mA
	$V_{CC} = 4.5V$, $V_{OL} = 0.4V$	0.4			mA
Output Source Current					
S_A-S_G (I_{OH})	$V_{CC} = 9.5V$, $V_{OH} = 2.0V$	−3.0		−35	mA
	$V_{CC} = 6.0V$, $V_{OH} = 2.0V$	−3.0		−25	mA

AC Electrical Characteristics $0°C \leq T_A \leq 70°C$, $4.5V \leq V_{CC} \leq 9.5V$, unless otherwise specified

Parameter	Conditions	Min.	Typ.	Max.	Units
OSC IN		100		266.67	kHz
Frequency		40		60	%
Duty Cycle				1	μs
Rise Time				1	μs
Fall Time					
Internal Time Base (= 4/Frequency)		15		40	μs
OSC IN Using RC	$R = 56k\Omega \pm 5\%$,				
Frequency	$C = 100pF \pm 10\%$	140		266.67	kHz
Internal Time Base (= 4/Frequency)		15		28	μs
Inputs					
Up/Down, Display Select				8	μs
t_{SETUP}				1	μs
t_{HOLD}					
$\overline{Count}$				2	μs
t_{SETUP}				1	μs
t_{HOLD}					

AC Electrical Characteristics (continued) $0°C \leq T_A \leq 70°C$, $4.5V \leq V_{CC} \leq 9.5V$, unless otherwise specified

Parameter	Conditions	Min.	Typ.	Max.	Units
$\overline{\text{Count}}$ Input Frequency	4 Digit Decimal Up Count				
	OSC IN = 266.67 kHz			14.4	kHz
	OSC IN = 100 kHz			5.43	kHz
	4 Digit Decimal Down Count				
	OSC IN = 266.67 kHz			13.6	kHz
	OSC IN = 100 kHz			5.13	kHz
	8 Digit Decimal Up Count				
	OSC IN = 266.67 kHz			9.52	kHz
	OSC IN = 100 kHz			3.57	kHz
	8 Digit Decimal Down Count				
	OSC IN = 266.67 kHz			9.17	kHz
	OSC IN = 100 kHz			3.44	kHz
	16 Bit Binary Up Count				
	OSC IN = 266.67 kHz			16.3	kHz
	OSC IN = 100 kHz			6.14	kHz
	16 Bit Binary Down Count				
	OSC IN = 266.67 kHz			15.3	kHz
	OSC IN = 100 kHz			5.76	kHz
	32 Bit Binary Up Count				
	OSC IN = 266.67 kHz			11.2	kHz
	OSC IN = 100 kHz			4.21	kHz
	32 Bit Binary Down Count				
	OSC IN = 266.67 kHz			10.3	kHz
	OSC IN = 100 kHz			3.86	kHz
Pulse Width (= 8/OSC IN Frequency)	OSC IN = 100 kHz	80			μs
	OSC IN = 266.67 kHz	30			μs
$\overline{\text{RESET}}$ Input Pulse Width	Resetting device while device running				
	OSC IN = 100 kHz	160			μs
	OSC IN = 266.67 kHz	60			μs

Functional Description

The MM57436 will count pulses at its count input and will display 4 digits of the resultant count. Under user control the device will count in either decimal or binary and will either count up or count down. The user may also select which group of 4 digits (16 bits) is to be displayed.

The display is standard, seven-segment for the decimal counter. In the binary mode, hex characters are displayed as follows:

0-9, A, b, C, d, E, F

The mode controls of the MM57436 are as follows:

Decimal/Binary — With this pin left open or tied to V_{CC}, the MM57436 is a decimal counter. Connecting this pin to output D1 converts the MM57436 to a binary counter. This mode is a strap option and may *not* be changed while the device is running.

4/8-Digit Decimal (16/32-Bit Binary) — With this pin left open or tied to V_{CC} the MM57436 is a 4-digit decimal or 16-bit binary counter. Connecting this pin to ground converts the MM57436 to an 8-digit decimal or 32 bit binary counter. The counter length is a strap option and may *not* be changed while the device is running.

Up/Down — With this pin left open or at a logic "1" (positive logic) the MM57436 will increment its internal counter by 1 with every pulse input at the $\overline{\text{COUNT}}$ input. With this pin connected to ground or to a logic "0" (positive logic), the MM57436 will *decrement* its internal counter by 1 with every pulse at the $\overline{\text{COUNT}}$ input. This input may be tied high or low, may come from a switch or may be controlled by a logic signal. It may be changed by the user at any time. Note, if this input is to be controlled by a mechanical switch some external debounce protection may be required depending on the application. There is no debounce protection internally on this input.

Display Select — With this input tied to V_{CC} or at a logic "1", the MM57436 will display the upper 4 digits (16 bits) of the 8 digit (32 bit) counter. Connecting this pin to ground or to a logic "0" will cause the lower 4 digits of the 8 digit counter to be displayed. If the MM57436 is operating as a 4-digit counter (pin 19 open or at V_{CC}) the Display Select input is ignored and has no effect whatsoever on the display. This input may be hard wired to either V_{CC} or ground; may be controlled by a switch or may be controlled by a logic signal. The input may be changed at any time by the user without impairing the operation of the device.

General Operation

Initialization

The $\overline{\text{RESET}}$ logic will clear the MM57436 if the power supply rise time is between 1 ms and 1 μs. If the power supply rise time is greater than 1 ms, the user must provide an external RC network and diode to the $\overline{\text{RESET}}$ pin as shown below (Figure 2). The $\overline{\text{RESET}}$ input is configured as a Schmitt trigger input. The user may control this with an external signal if desired as long as the proper levels are maintained. The $\overline{\text{RESET}}$ pin is the means by which the user may clear the counter. $\overline{\text{RESET}}$ may be brought low at any time. The MM57436 will be cleared whenever the proper "0" level is applied at the $\overline{\text{RESET}}$ input provided the input stays low for at least 16 clock cycles. If the reset pin is not used it should be connected to V_{CC}.

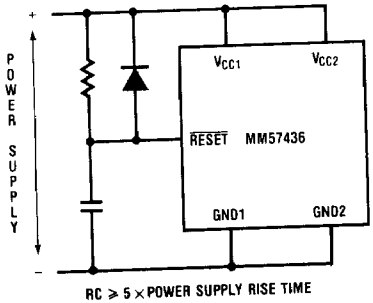


Figure 2. Power-Up Clear Circuit

Oscillator

The user has the option of connecting an RC network to the OSC IN pin and using the internal oscillator or he may supply an external oscillator to the OSC IN pin. The OSC IN input is a Schmitt trigger input and the user must insure that the proper levels are met when supplying an external clock.

The external oscillator is recommended when the counting speed and/or the stability of the counting speed is critical. The internal RC oscillator is only accurate to about ±15% to ±20%. However, if practical in the application, the RC network can be tuned for the desired operating frequency. Some typical RC values that place the operating speed at near the maximum are shown below (Figure 3).

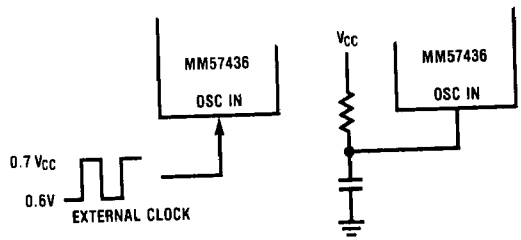
Power Supply

The MM57436 has two V_{CC} pins: V_{CC1} and V_{CC2} — and two ground pins: GND1 and GND2. Both V_{CC1} and V_{CC2} *must* be connected to the positive supply (V_{CC}). Both GND1 and GND2 *must* be connected to ground. Failure to do this will result in improper operation of the MM57436.

$\overline{\text{Count}}$ Input

The MM57436 counts negative-going pulses at the $\overline{\text{Count}}$ Input. The width of the negative-going (logic "1" to logic "0") must be at least 8 times the oscillator cycle time.

In order to maximize the counting speed and not to miss any pulses, during the display cycles, the MM57436 has a 4-bit register at the $\overline{\text{COUNT}}$ input which will accumulate up to 15 counts. This register is added/subtracted from the counter. Therefore at the higher input count speeds, when the counter is changed from an up counter to a down counter or vice versa, there is a window of up to 15 counts — the maximum value in the input register — in the count. This effect is completely unobservable at slow input count speeds and gradually becomes more noticeable as the repetition rate of the count pulse increases. If the up/down mode is not changed during operation, the only observable effect of the input register is that the display may appear to increment or decrement by values greater than 1.



RC Controlled Oscillator		
R(kΩ)	C(pF)	OSC IN Period (μs)
51	100	4.75 ± 15%
82	56	4.75 ± 13%

Figure 3. MM57436 Oscillator

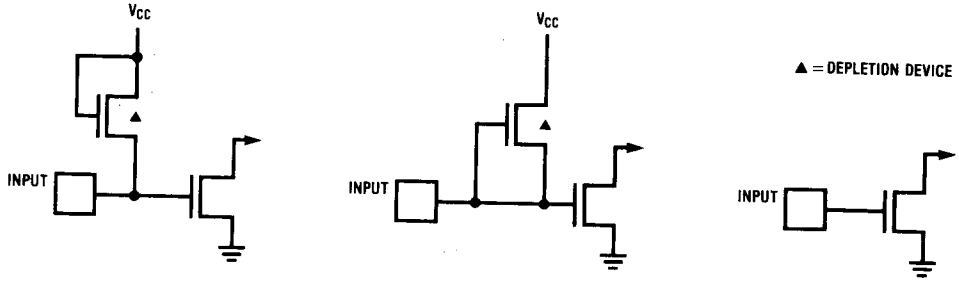
Input/Output Characteristics

Inputs

The MM57436 has three types of inputs. Figure 4a is the input with a depletion load to V_{CC} found on pins 17, 18, and 19 (Decimal/Binary, Up/Down, 4/8 Digit). Figure 4b is a slightly different type of input with a depletion load to V_{CC} found on pins 4 and 14 ($\overline{\text{RESET}}$, $\overline{\text{COUNT}}$). The remaining input, pin 5-Display Select, has no load device (Figure 4c).

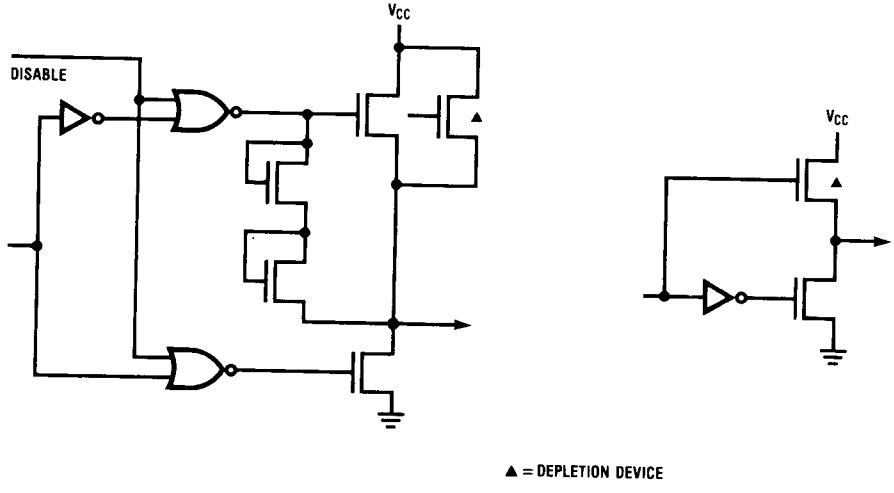
Outputs

There are only two types of outputs on the MM57436: the segment drivers (Figure 5a) and the digit drivers (Figure 5b).



a. Pins 17, 18, 19 b. Pins 4, 14 c. Pin 5

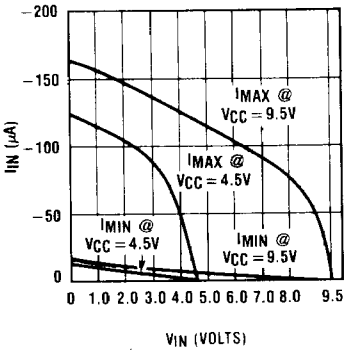
Figure 4. Input Configurations



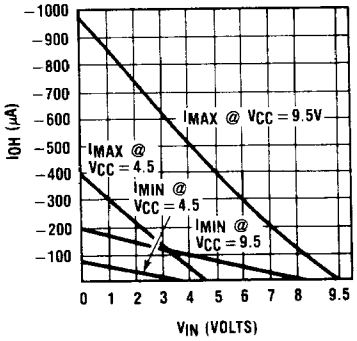
a. Segment Driver Outputs b. Digit Driver Outputs

Figure 5. Output Configurations

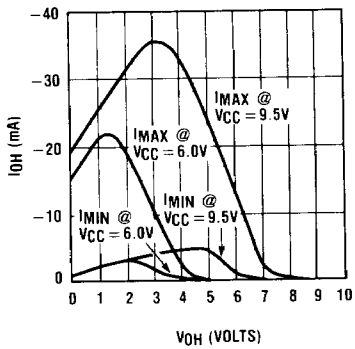
Input Current $\overline{\text{RESET}}$, Count



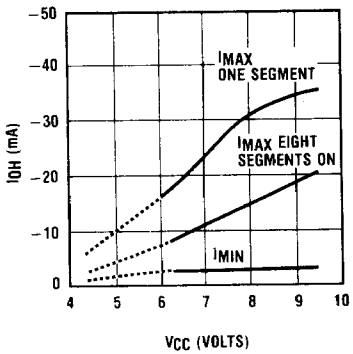
Input Current Decimal/ Binary, Up/Down, 4/8 Digit



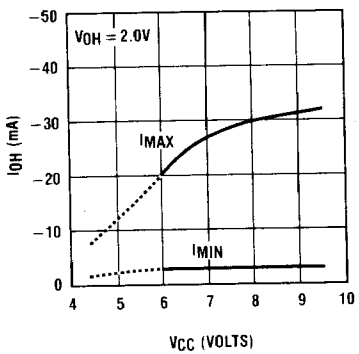
S_a-S_g LED Output Source Current



LED Output Direct Segment and Digit Drive



LED Output Direct Segment Drive



Output Sink Current for D_0-D_3

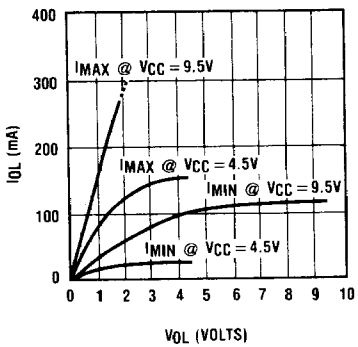


Figure 6. I/O DC Current Characteristics

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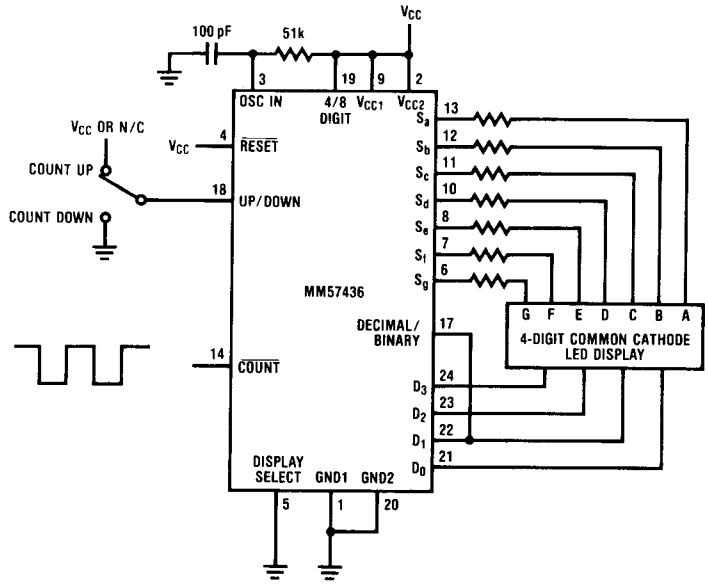

Figure 7. MM57436 as 16-Bit Binary Counter with RC Oscillator and Switch-Controlled Up/Down Mode

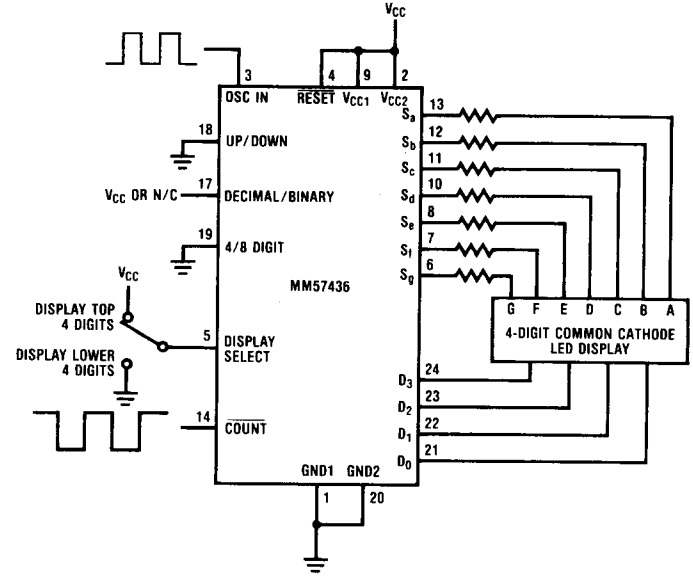

Figure 8. MM57436 as 8-Digit Decimal Down Counter with Extenal Oscillator