

Project_V06 Cruise Speed Control Simulation

Truth Tables and Circuit Information - TC7107 / LM35 analog display solution with 74LS85 comparator and NE555 flashing warning stage

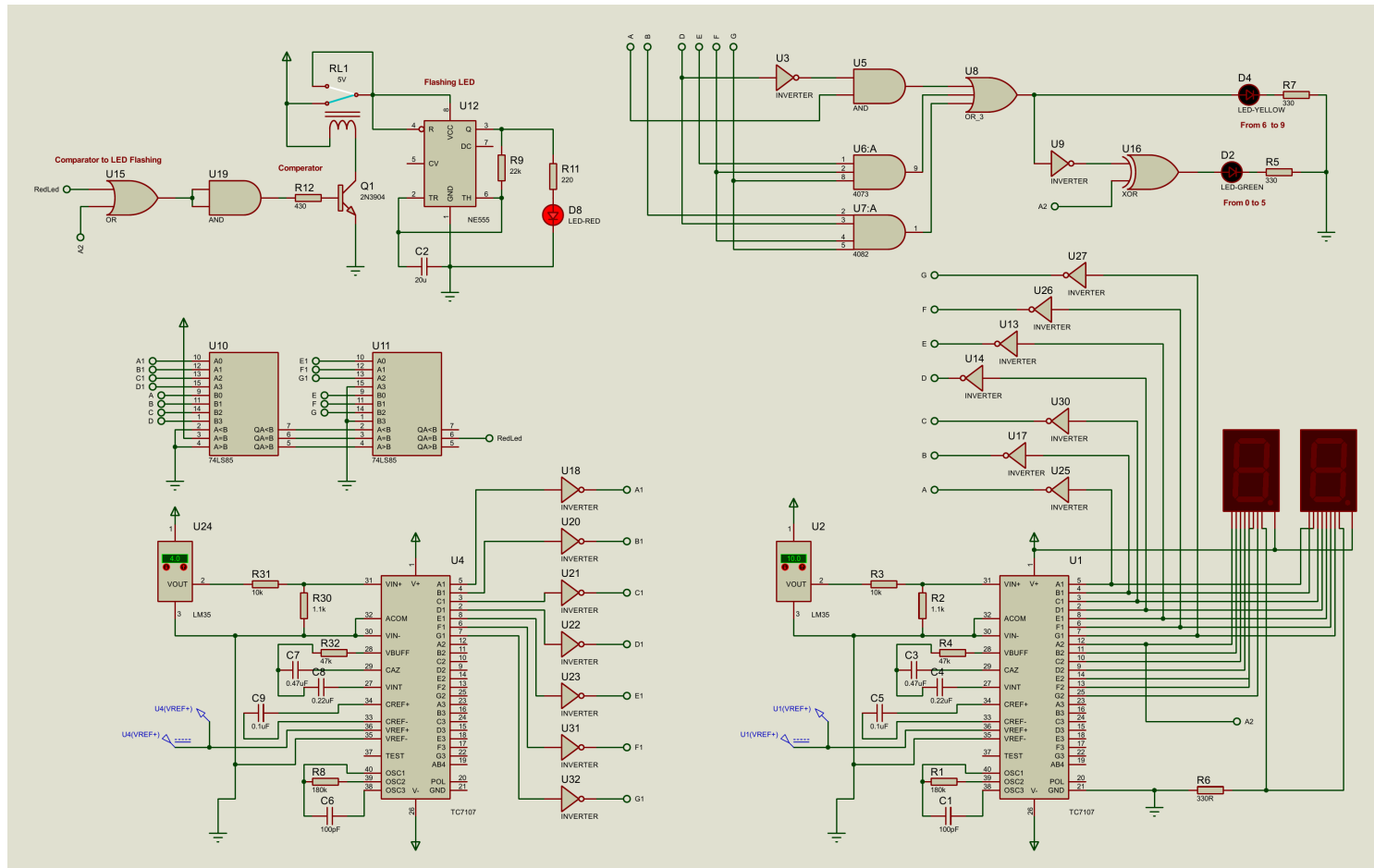


Figure 1: Project_V06 circuit diagram showing the TC7107 display stage, LM35 analog detector inputs, green/yellow logic, cascaded 74LS85 comparator section, transistor/relay driver, and NE555 red flashing LED stage.

This truth-table pack is based on the uploaded Project_V06 circuit. The circuit uses electronic components only: analog sensor inputs, TC7107 display/ADC sections, logic gates, comparator ICs, a transistor/relay enable path, and an NE555 timer. The tables are written for report use and separate the display, range indicators, comparator, warning, and maximum-speed logic.

1. Working circuit comment

The Project_V06 solution uses two LM35 analog detector/reference inputs and TC7107 display/ADC circuits to show the simulated speed values. The normalized seven-segment signals are reused as logic inputs for the green and yellow range indicators. The green LED is used for speeds 0 to 5, the yellow/amber LED is used for speeds 6 to 9, and the red LED flashes when the comparator detects that the selected cruise speed has been reached or passed. The maximum displayed speed is 10, represented by the tens display showing 1 and the units display showing 0.

1.1 Main component function table

Component / label	Circuit part	Purpose in the Project_V06 cruise-speed solution
U1	TC7107	Main TC7107 analog-to-display section for the current speed display and segment logic outputs.
U4	TC7107	Second TC7107 analog/display section used for the reference/set-speed side of the comparator logic.
U2, U24	LM35	Analog detector/reference input sources. Their output voltages are scaled and displayed by the TC7107 stages.
Two 7-segment displays	LED displays	Show the current speed as a two-digit value, including the maximum value 10.
U18, U20, U21, U22, U23, U31, U32	Inverters	Create normalized A1 to G1 signals for the comparator/reference side.
U25, U17, U30, U14, U13, U26, U27	Inverters	Create normalized A to G signals for the display/range logic side.
U5, U6:A, U7:A	AND gates	Generate yellow-range detection terms from the segment outputs.
U8	3-input OR gate	Combines yellow detection terms to produce the yellow/amber range signal.
U9 and U16	Inverter and XOR gate	Generate the final green range signal and inhibit/modify it when the tens digit is active.
U10, U11	74LS85 comparators	Compare the current speed signal with the selected/reference speed signal.
U15, U19	OR and AND gates	Combine comparator outputs and enable the red flashing warning path.
Q1, RL1	2N3904 transistor and relay	Drive and isolate the NE555 warning section when the comparator output is active.
U12	NE555 timer	Astable flashing circuit for the red warning LED.
D2, D4, D8	Green, yellow, red LEDs	Speed-range and warning indicators.

1.2 Overall signal-flow table

Stage	Signal path	Meaning
Analog detection	LM35 output -> TC7107 input	Analog voltage represents the simulated speed/reference value.
Display	TC7107 segment outputs -> two 7-segment displays	Displays the current speed value from 00 up to 10.
Range logic	Segment signals A, B, D, E, F, G -> logic gates	Separates green 0-5 from yellow 6-9.
Maximum-speed inhibit	Tens-active signal A2 -> XOR/inhibit section	Prevents the normal green/yellow range indication from treating 10 as 0.
Comparator	Current speed signals -> 74LS85 A-side; set/reference signals -> 74LS85 B-side	Detects whether current speed is lower than, equal to, or greater than the selected cruise speed.
Flashing warning	Comparator RedLed signal -> transistor/relay -> NE555 -> red LED	Flashes red when the cruise speed has been reached or exceeded.

2. Display and analog input truth tables

The analog detector stage is calibrated so that the TC7107 display represents the speed range from 00 to 10. The exact voltage scaling depends on the chosen reference and resistor values, but the table below shows the intended project-level interpretation of the displayed speed.

Speed value	Example analog input	Tens display	Unit display	Meaning
0	0.00 V	0	0	Green range
1	0.10 V	0	1	Green range
2	0.20 V	0	2	Green range
3	0.30 V	0	3	Green range
4	0.40 V	0	4	Green range
5	0.50 V	0	5	Green range
6	0.60 V	0	6	Yellow/amber range
7	0.70 V	0	7	Yellow/amber range
8	0.80 V	0	8	Yellow/amber range
9	0.90 V	0	9	Yellow/amber range
10	1.00 V	1	0	Maximum speed

2.1 Normalized seven-segment truth table

The range logic uses normalized segment signals A, B, C, D, E, F and G. In this table, 1 means the displayed segment is ON and 0 means the displayed segment is OFF.

Digit	A	B	C	D	E	F	G	Pattern ABCDEFG	Display
0	1	1	1	1	1	1	0	1111110	0
1	0	1	1	0	0	0	0	0110000	1
2	1	1	0	1	1	0	1	1101101	2
3	1	1	1	1	0	0	1	1111001	3
4	0	1	1	0	0	1	1	0110011	4
5	1	0	1	1	0	1	1	1011011	5
6	1	0	1	1	1	1	1	1011111	6
7	1	1	1	0	0	0	0	1110000	7
8	1	1	1	1	1	1	1	1111111	8
9	1	1	1	1	0	1	1	1111011	9

2.2 TC7107 display/logic signal table

Signal group	Example labels in circuit	Use
Current-speed display outputs	A, B, C, D, E, F, G and A2	Drive the display and feed the green/yellow range logic. A2 is used as a tens-active/max-speed signal.
Reference/set display outputs	A1, B1, C1, D1, E1, F1, G1	Feed the comparator/reference side after inversion/normalisation.
TC7107 analog inputs	VIN+, VIN-, ACOM, VREF+, VREF-	Set the measured and reference voltage levels for the display reading.
Oscillator/reference pins	OSC1, OSC2, OSC3, CREF+, CREF-	Support TC7107 conversion timing and reference stability.

3. Green and yellow LED range logic

The circuit uses the seven-segment outputs instead of a separate BCD decoder output to detect the speed range. The same segment logic used in the earlier working unit-counter method is retained, with an additional tens-active signal to avoid treating the displayed value 10 as the digit 0.

Logic term	Equation	Purpose
Y1	$A \cdot \text{NOT } D$	Detects the digit 7 condition.
Y2	$E \cdot F \cdot G$	Detects part of the 6 and 8 conditions.
Y3	$A \cdot B \cdot F \cdot G$	Detects part of the 8 and 9 conditions.
Yellow	$Y1 + Y2 + Y3$	Yellow/amber ON for 6, 7, 8 and 9.
Green raw	NOT Yellow	Green ON for 0 to 5 before the maximum-speed inhibit is applied.
Green final	$(\text{NOT Yellow}) \text{ XOR } A2$	Final green output. When A2 is active at 10, green is forced OFF.

3.1 Full green/yellow range truth table

Speed	Tens A2	Unit digit	A	B	D	E	F	G	Y1	Y2	Y3	Yellow	Green	Result
0	0	0	1	1	1	1	1	0	0	0	0	0	1	Green ON
1	0	1	0	1	0	0	0	0	0	0	0	0	1	Green ON
2	0	2	1	1	1	1	0	1	0	0	0	0	1	Green ON
3	0	3	1	1	1	0	0	1	0	0	0	0	1	Green ON
4	0	4	0	1	0	0	1	1	0	0	0	0	1	Green ON
5	0	5	1	0	1	0	1	1	0	0	0	0	1	Green ON
6	0	6	1	0	1	1	1	1	0	1	0	1	0	Yellow ON
7	0	7	1	1	0	0	0	0	1	0	0	1	0	Yellow ON
8	0	8	1	1	1	1	1	1	0	1	1	1	0	Yellow ON
9	0	9	1	1	1	0	1	1	0	0	1	1	0	Yellow ON
10	1	0	1	1	1	1	1	0	0	0	0	0	0	Max 10 - red warning range

4. 74LS85 comparator truth tables

The comparator section checks whether the current speed has reached or passed the selected cruise speed. The Project_V06 figure uses two 74LS85 comparators so that the normalized segment/reference signals can be compared and then combined into the RedLed warning signal.

Comparator block	A-side input meaning	B-side input meaning	Output used
U10 74LS85	Current/reference segment group A1, B1, C1, D1	Selected set-speed segment/reference group	Cascaded/combined comparison result
U11 74LS85	Current/reference segment group E1, F1, G1 with cascade input	Selected set-speed segment/reference group	RedLed comparator output path
U15 OR + U19 AND	Comparator status outputs and A2/tens logic	Enable condition	Final warning-enable signal to Q1 and NE555 path

4.1 Comparator operation truth table

Current speed condition	QA>B	QA=B	QA<B	RedLed/F	Red flashing LED
Current speed < set speed	0	0	1	0	OFF
Current speed = set speed	0	1	0	1	Flashing
Current speed > set speed	1	0	0	1	Flashing

4.2 Set-speed/reference segment table

Set speed	A	B	C	D	E	F	G	Pattern ABCDEFG	Warning meaning
6	1	0	1	1	1	1	1	1011111	Red flashes when current speed >= 6
7	1	1	1	0	0	0	0	1110000	Red flashes when current speed >= 7
8	1	1	1	1	1	1	1	1111111	Red flashes when current speed >= 8
9	1	1	1	1	0	1	1	1111011	Red flashes when current speed >= 9
10	Unit 0	Unit 0	Unit 0	Unit 0	Unit 0	Unit 0	Unit 0	Tens A2 = 1, Unit = 0	Maximum speed condition

4.3 Example comparator operation when selected cruise speed = 6

Selected cruise speed	Current display	Comparator condition	RedLed/F	Red LED
6	04	Current < Set	0	OFF
6	05	Current < Set	0	OFF
6	06	Current = Set	1	Flashing
6	07	Current > Set	1	Flashing
6	09	Current > Set	1	Flashing
6	10	Current > Set	1	Flashing

5. NE555 flashing red LED and cruise reset logic

The red flashing LED is controlled by the comparator output and not by the green/yellow range logic. When the comparator output is LOW, the transistor and relay/enable path are OFF and the NE555 is disabled. When the comparator output is HIGH, the NE555 astable circuit runs and the red LED flashes. This gives an automatic cruise-warning reset when the speed falls below the selected cruise speed; it is not a normal push-button reset.

5.1 NE555 connection table

NE555 pin	Name	Connection/use in circuit
1	GND	Ground.
8	VCC	+5 V supply rail.
4	RESET	Enabled by the comparator/transistor/relay path. HIGH allows flashing.
2	TRIG	Connected into the astable timing network.
6	THRESH	Connected into the astable timing network.
7	DISCH	Connected to the timing resistor/capacitor network.
5	CV	Control-voltage capacitor connection.
3	OUT	Flashing output to the red LED through a resistor.

5.2 Red flashing warning truth table

Comparator RedLed/F	Q1 transistor	Relay/enable path	NE555 state	Red LED state
0	OFF	OFF / not energised	Disabled	OFF
1	ON	ON / energised	Enabled astable mode	Flashing

5.3 Cruise warning reset / maximum-speed table

Condition	Comparator output	Action	Why this is a cruise reset and not a normal reset button
Current speed below selected speed	0	NE555 warning path is disabled; red LED OFF.	The warning resets automatically because the comparator condition is no longer true.
Current speed equal to selected speed	1	NE555 warning path enabled; red LED flashes.	The cruise speed has been reached.
Current speed above selected speed but below 10	1	Red LED continues flashing.	The speed has passed the selected cruise value.
Current speed = 10	1 if set speed <= 10	Maximum speed is displayed as 10 and red warning remains available.	The system shows the max speed and does not rely on a push-button reset.

6. Final operating summary

Displayed speed	Green LED	Yellow/amber LED	Red flashing LED	System meaning
00 to 05	ON	OFF	Depends on comparator set speed	Normal/low speed range.
06 to 09	OFF	ON	Depends on comparator set speed	Higher speed range before maximum.
10	OFF	OFF	Flashing when comparator warning condition is active	Maximum speed display condition.
Current speed < set speed	Range LED works normally	Range LED works normally	OFF	Cruise warning not reached.
Current speed = set speed	Range LED works normally	Range LED works normally	Flashing	Selected cruise speed reached.
Current speed > set speed	Range LED works normally	Range LED works normally	Flashing	Selected cruise speed passed.