

16 bit Seri-In/Parallel-Out Constant-Current LED Driver

Description

The ME2656 is designed for LED displays and LED lighting applications. The ME2656 contains a 16-bit shift register and data latches, which convert serial input data into parallel output format. At the ME2656 output stage, 16 regulated current ports provide uniform and constant current for driving LEDs within a wide range of VF variations. Used in system design for LED display applications (e.g., LED panels), the ME2656 provides great flexibility and device performance. Users can adjust the output current from 3 mA to 45 mA through an external resistor, R_{ext} which gives flexibility in controlling the light intensity of LEDs. ME2656 is designed for up to 12 V at the output port. The high clock frequency, 25 MHz, also satisfies the system requirements of high-volume data transmission. The serial data is transferred into ME2656 via SDI, shifted in the shift register, and transferred out via SDO. LE can latch the serial data in the shift register to the output latch. OE enables the output drivers to sink current.

Features

- Constant Output Current Invariant to Voltage
- Constant current range:
3-45mA@ $V_{DD}=5V$
3-30mA@ $V_{DD}=3.3V$
- Excellent Output Current Accuracy:
–Between Channels: $< \pm 2.5\%$ (Max)
–Between ICs: $< \pm 3\%$ (Max)
- Output Current Adjusted By External Resistor
- Fast Response of Output Current, OE (Min):50ns
- Staggered output delay: 10ns
- ESD Performance: 4kV HBM
- 3.3V to 5V Supply Voltage
- Schmitt trigger input
- 25-MHz Clock Frequency

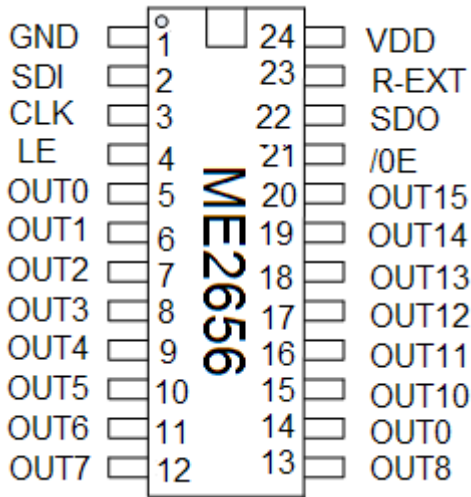
APPLICATIONS

- LED Display Systems
- LED Traffic Signs
- Variable Message Signs

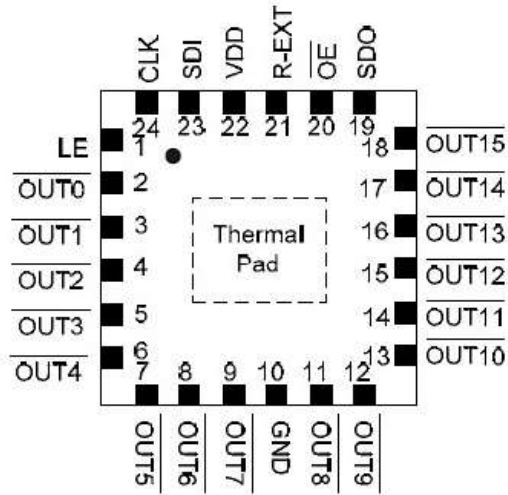
Selection Guide

Product Name	Package	MARK
ME2656Q24AG	SSOP24-0.635	2656A
ME2656Q24BG	SSOP24-1.00	2656B
ME2656QF24AG	QFN24L-4*4-0.5	2656A

Pin Configurations



SSOP24-0.635 , SSOP24-1.0

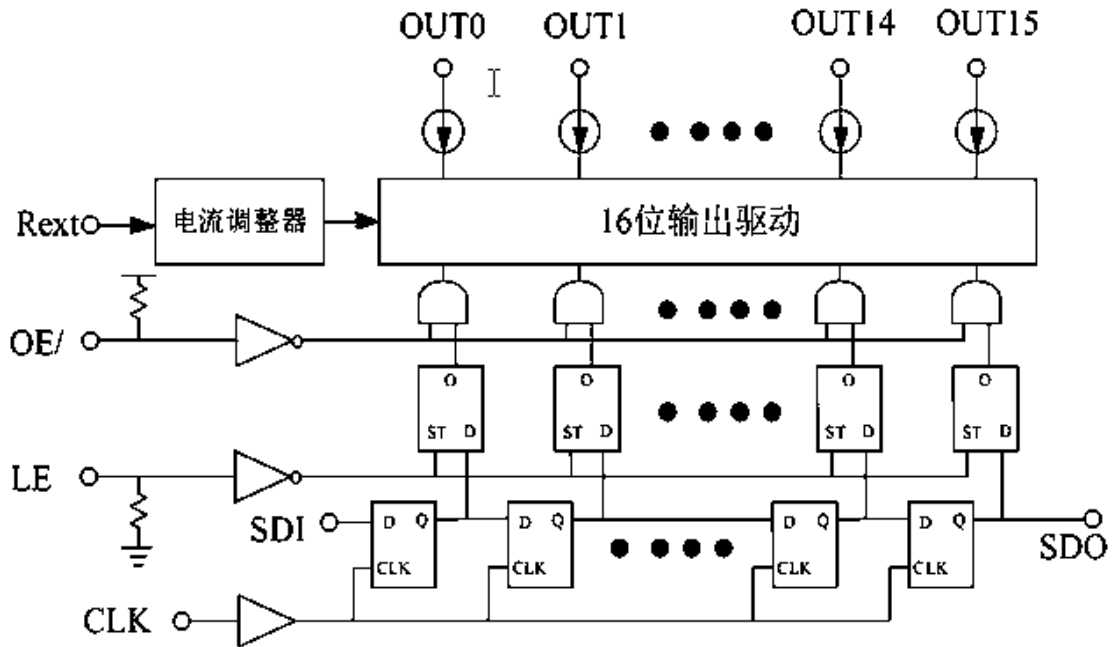


QFN24L-4*4-0.5

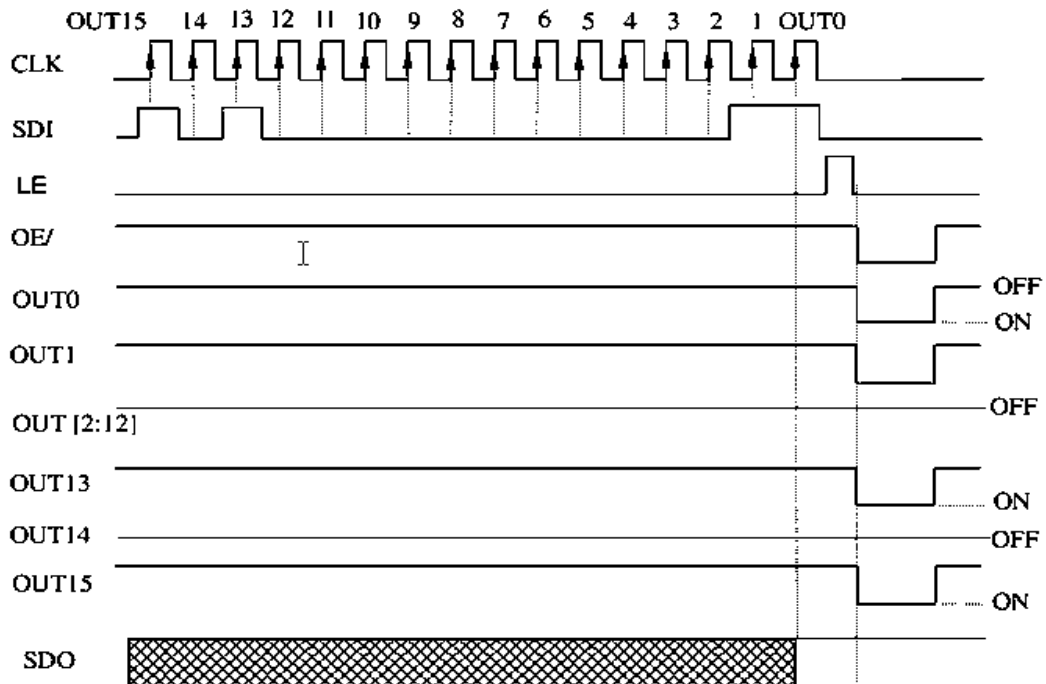
Terminal Description

Pin	Name	Function
	GND	Ground terminal.
	SDI	Serial input of data shift register.
	CLK	Clock input of shift register, data is sampled at the rising edge of CLK.
	LE	Input terminal of data strobe. Data is latched when LE is low. And data on shift register goes through when LE is high.
	OUT[0:15]	Open-drain, constant-current outputs.
	OE/	Output enable signal. Output is enabled when OE/ is forced to low.
	SDO	Output terminal of serial-data output to the SDI of next ME2656.
	R-EXT	Used to connect an external resistor for setting up all output current.
	VDD	Supply voltage terminal.

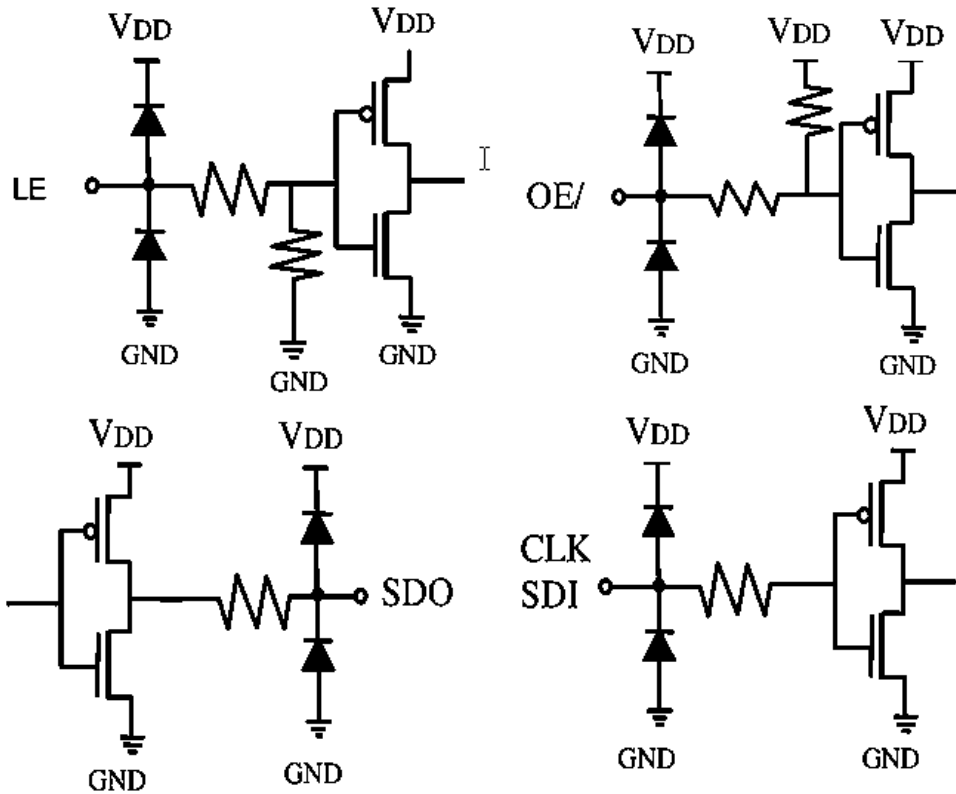
Block Diagram



Timing Diagram



Equivalent Circuits of Inputs and Output



Maximum Ratings

Characteristic		Symbol	Rating	Unit
Supply Voltage		V_{DD}	0~7.0	V
Input Voltage		V_{IN}	-0.4~ $V_{DD}+0.4$	V
Output Current		I_{OUT}	+50	mA
Output Voltage		V_{DS}	-0.5~+12	V
Clock Frequency		F_{CLK}	25	MHz
Total GND Terminals Current		I_{GND}	+1000	mA
Power Dissipation	SSOP24-0.635	P_D	2.03	W
	SSOP24-1.0		2.52	
	QFN24L-4*4-0.5		3.12	
Thermal Resistance	SSOP24-0.635	$R_{TH(j-a)}$	61	°C/W
	SSOP24-1.0		49	
	QFN24L-4*4-0.5		40	
Operating Temperature		T_{OPR}	-40~85	°C
Storage Temperature		T_{STG}	-55~150	°C

Electrical Characteristics (VDD=5.0V)

Characteristic		Symbol	Condition		Min	Typ	Max	Unit
Supply Voltage		V_{DD}	-		3.0	5.0	5.5	V
Output Voltage		V_{DS}	OUT0~OUT15		-	-	12	V
Output Current		I_{OUT}	$V_{DS}=1.0\sim 4.0$		3	-	45	mA
		I_{OH}	SDO		-	-	-1.0	mA
		I_{OL}	SDO		-	-	1.0	mA
Input Voltage	"H" level	V_{IH}	$T_a=-40\sim 80^{\circ}C$		$0.7*V_{DD}$	-	VDD	V
	"L" level	V_{IL}	$T_a=-40\sim 80^{\circ}C$		GND	-	$0.3*V_{DD}$	V
Output Leakage Current		I_{OUT}	$V_{DS}=12V$		-	-	0.5	μA
Output Voltage	SDO	V_{OL}	$I_{OL}=+1.0mA$		-	-	0.4	V
		V_{OH}	$I_{OH}=-1.0mA$		4.6	-	-	V
Output Current 1		I_{OUT1}	$V_{DS}=1.0V$	$R_{EXT}=1.24k\Omega$	-	15	-	mA
Current Skew		dI_{OUT1}	$V_{DS}=1.0V$ $R_{EXT}=1.24k\Omega$	$I_{OL}=15mA$	-	± 1.5	± 2.5	%
Output Current 2		I_{OUT1}	$V_{DS}=1.0V$	$R_{EXT}=470\Omega$	-	40	-	mA
Current Skew		dI_{OUT1}	$V_{DS}=1.0V$ $R_{EXT}=470\Omega$	$I_{OL}=40mA$	-	± 1.5	± 2	%
Output Current vs. Output Voltage Regulation		$\%/dV_{DS}$	V_{DS} within 1.0V and 3.0V		-	± 0.1	-	%/V
Output Current vs. Supply Voltage Regulation		$\%/dV_{DD}$	V_{DD} within 4.5 and 5.5V		-	-	± 1.0	%/V
Pull-up Resistor		$R_{IN(up)}$	/OE		300	600	800	K Ω
Pull-down Resistor		$R_{IN(down)}$	LE		300	600	800	K Ω
Supply Current	"OFF"	$I_{DD(off)1}$	$R_{EXT}=open, OUT0\sim OUT15=OFF$		-	1.5	5	mA
		$I_{DD(off)2}$	$R_{EXT}=1.26K\Omega, OUT0\sim OUT15=OFF$		-	6.7	8	
		$I_{DD(off)3}$	$R_{EXT}=475\Omega, OUT0\sim OUT15=OFF$		-	4.5	10	
	"ON"	$I_{DD(on)1}$	$R_{EXT}=1.26K\Omega, OUT0\sim OUT15=ON$		-	7.67	8	
		$I_{DD(on)2}$	$R_{EXT}=475\Omega, OUT0\sim OUT15=ON$		-	5.4	10	

Electrical Characteristics (VDD=3.3V)

Characteristic		Symbol	Condition		Min	Typ	Max	Unit
Supply Voltage		V_{DD}	-		3.0	3.3	4.5	V
Output Voltage		V_{DS}	OUT0~OUT15		-	-	12	V
Output Current		I_{OUT}	$V_{DS}=1.0\sim 4.0$		3	-	45	mA
		I_{OH}	SDO		-	-	-1.0	mA
		I_{OL}	SDO		-	-	1.0	mA
Input Voltage	“H” level	V_{IH}	$T_a=-40\sim 80^{\circ}C$		$0.7*V_{DD}$	-	VDD	V
	“L” level	V_{IL}	$T_a=-40\sim 80^{\circ}C$		GND	-	$0.3*V_{DD}$	V
Output Leakage Current		I_{OUT}	$V_{DS}=17V$		-	-	0.5	uA
Output Voltage	SDO	V_{OL}	$I_{OL}=+1.0mA$		-	-	0.4	V
		V_{OH}	$I_{OH}=-1.0mA$		2.9	-	-	V
Output Current 1		I_{OUT1}	$V_{DS}=1.0V$	$R_{EXT}=6.2k\Omega$	-	3	-	mA
Current Skew		dI_{OUT1}	$V_{DS}=1.0V$ $R_{EXT}=6.2k\Omega$	$I_{OL}=3mA$	-	± 1.5	± 2.5	%
Output Current 2		I_{OUT1}	$V_{DS}=1.0V$	$R_{EXT}=744\Omega$	-	25	-	mA
Current Skew		dI_{OUT1}	$V_{DS}=1.0V$ $R_{EXT}=744\Omega$	$I_{OL}=25mA$	-	± 1.5	± 2	%
Output Current vs. Output Voltage Regulation		$\%/dV_{DS}$	V_{DS} within 1.0V and 3.0V		-	± 0.1	-	%/V
Output Current vs. Supply Voltage Regulation		$\%/dV_{DD}$	V_{DD} within 3.0 and 3.6V		-	-	± 1.0	%/V
Pull-up Resistor		$R_{IN(up)}$	/OE		300	600	800	K Ω
Pull-down Resistor		$R_{IN(down)}$	LE		300	600	800	K Ω
Supply Current	“OFF”	$I_{DD(off)1}$	$R_{EXT}=\text{open}, \text{OUT0}\sim\text{OUT15}=\text{OFF}$		-	1.7	2.2	mA
		$I_{DD(off)2}$	$R_{EXT}=1.26K\Omega, \text{OUT0}\sim\text{OUT15}=\text{OFF}$		-	4.5	6	
		$I_{DD(off)3}$	$R_{EXT}=760\Omega, \text{OUT0}\sim\text{OUT15}=\text{OFF}$		-	6.5	8	
	“ON”	$I_{DD(on)1}$	$R_{EXT}=1.26K\Omega, \text{OUT0}\sim\text{OUT15}=\text{ON}$		-	5.5	8	
		$I_{DD(on)2}$	$R_{EXT}=760\Omega, \text{OUT0}\sim\text{OUT15}=\text{ON}$		-	7.0	10	

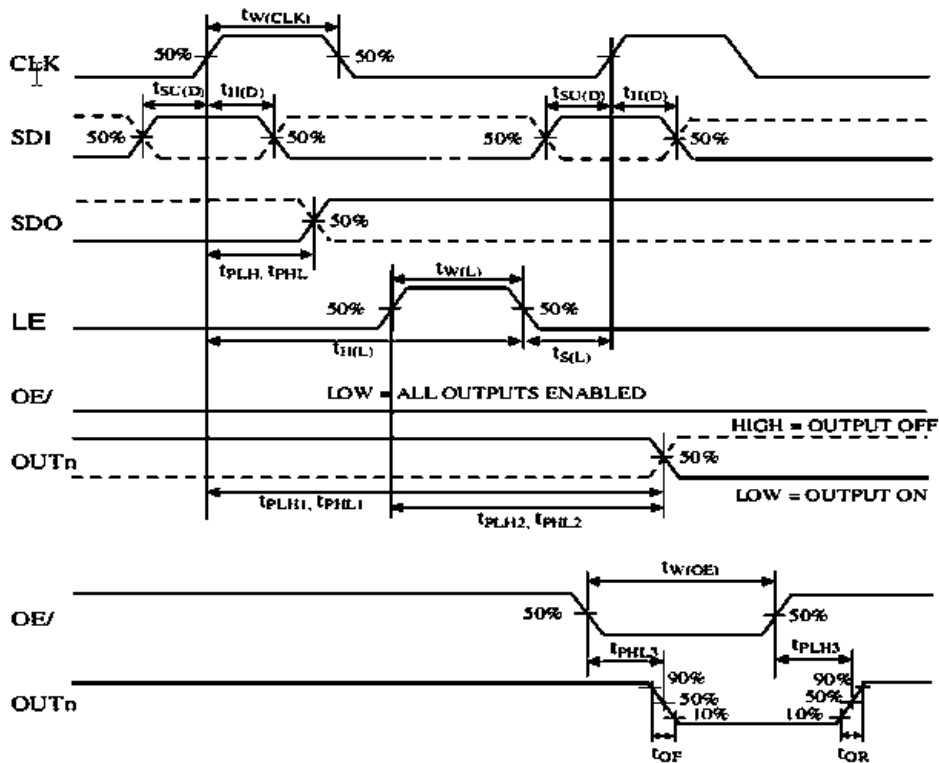
Switching Characteristics (VDD=5.0V)

Characteristic		Symbol	Condition	Min	Typ	Max	Unit
Propagation Delay Time ("L" to "H")	CLK-OUT2n	t_{pLH1}	$V_{DD}=5.0V$ $V_{DS}=1.0V$ $V_{IH}=V_{DD}$ $R_{EXT}=1K\Omega$ $V_L=4.5V$ $R_L=160\Omega$ $C_L=10pF$	-	50	70	ns
	CLK-OUT2n+1			-	35	55	ns
	LE-OUT2n	t_{pLH2}		-	50	70	ns
	LE- OUT2n+1			-	35	55	ns
	/OE-OUT2n	t_{pLH3}		-	50	70	ns
	/OE-OUT2n+1			-	35	55	ns
	CLK-SDO	t_{pLH}		-	20	40	ns
Propagation Delay Time ("H" to "L")	CLK-OUT2n	t_{pHL1}		-	90	110	ns
	CLK-OUT2n+1			-	75	95	ns
	LE-OUT2n	t_{pHL2}		-	90	110	ns
	LE- OUT2n+1			-	75	95	ns
	/OE-OUT2n	t_{pHL3}		-	90	110	ns
	/OE-OUT2n+1			-	75	95	ns
	CLK-SDO	t_{pHL}		-	20	40	ns
Pulse Width	CLK	$t_{w(CLK)}$	20	-	-	ns	
	LE	$t_{w(L)}$	20	-	-	ns	
	/OE	$t_{w(OE)}$	50	70	-	ns	
Hold Time for LE		$t_{h(L)}$	30	-	-	ns	
Setup Time for LE		$t_{su(L)}$	5	-	-	ns	
Hold Time for SDI		$t_{h(D)}$	5	-	-	ns	
Setup Time for SDI		$t_{su(D)}$	3	-	-	ns	
Maximum CLK Rise Time		t_r	-	-	500	ns	
Maximum CLK Fall Time		t_f	-	-	500	ns	
Rise Time of SDO		$t_{r,SDO}$	-	10	-	ns	
Fall Time of SDI		$t_{f,SDO}$	-	10	-	ns	
Output Rise Time of Iout		t_{or}	-	40	-	ns	
Output Fall Time of Iout		t_{of}	-	55	-	ns	

Switching Characteristics (VDD=3.3V)

Characteristic		Symbol	Condition	Min	Typ	Max	Unit
Propagation Delay Time ("L" to "H")	CLK-OUT2n	t_{pLH1}	$V_{DD}=3.3V$ $V_{DS}=1.0V$ $V_{IH}=V_{DD}$ $R_{EXT}=1K\Omega$ $V_L=3.0V$ $R_L=100\Omega$ $C_L=10pF$	-	50	70	ns
	CLK-OUT2n+1			-	35	55	ns
	LE-OUT2n	t_{pLH2}		-	50	70	ns
	LE-OUT2n+1			-	35	55	ns
	/OE-OUT2n	t_{pLH3}		-	50	70	ns
	/OE-OUT2n+1			-	35	55	ns
	CLK-SDO	t_{pLH}		-	20	40	ns
Propagation Delay Time ("L" to "H")	CLK-OUT2n	t_{pHL1}		-	115	135	ns
	CLK-OUT2n+1			-	100	120	ns
	LE-OUT2n	t_{pHL2}		-	115	135	ns
	LE-OUT2n+1			-	100	120	ns
	/OE-OUT2n	t_{pHL3}		-	105	125	ns
	/OE-OUT2n+1			-	90	110	ns
	CLK-SDO	t_{pHL}		-	20	40	ns
Pulse Width	CLK	$t_{w(CLK)}$	20	-	-	ns	
	LE	$t_{w(L)}$	20	-	-	ns	
	/OE	$t_{w(OE)}$	70	90	-	ns	
Hold Time for LE		$t_{h(L)}$	30	-	-	ns	
Setup Time for LE		$t_{su(L)}$	5	-	-	ns	
Hold Time for SDI		$t_{h(D)}$	5	-	-	ns	
Setup Time for SDI		$t_{su(D)}$	3	-	-	ns	
Maximum CLK Rise Time		t_r	-	-	500	ns	
Maximum CLK Fall Time		t_f	-	-	500	ns	
Rise Time of SDO		$t_{r,SDO}$	-	10	-	ns	
Fall Time of SDI		$t_{f,SDO}$	-	10	-	ns	
Output Rise Time of Iout		t_{or}	-	40	-	ns	
Output Fall Time of Iout		t_{of}	-	60	-	ns	

Timing Waveform

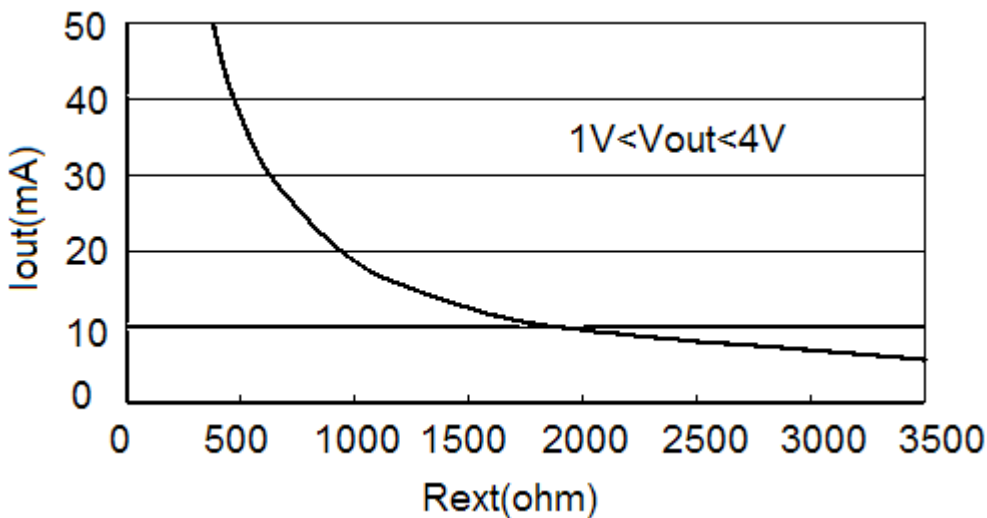


Adjusting Output Current

All ME2656's output current (I_{OUT}) are set by one external resistor at pin Rext. The output current can be calculated from the equation:

$$I_{out} = 1.24V \times (1/R_{ext}) \times 15$$

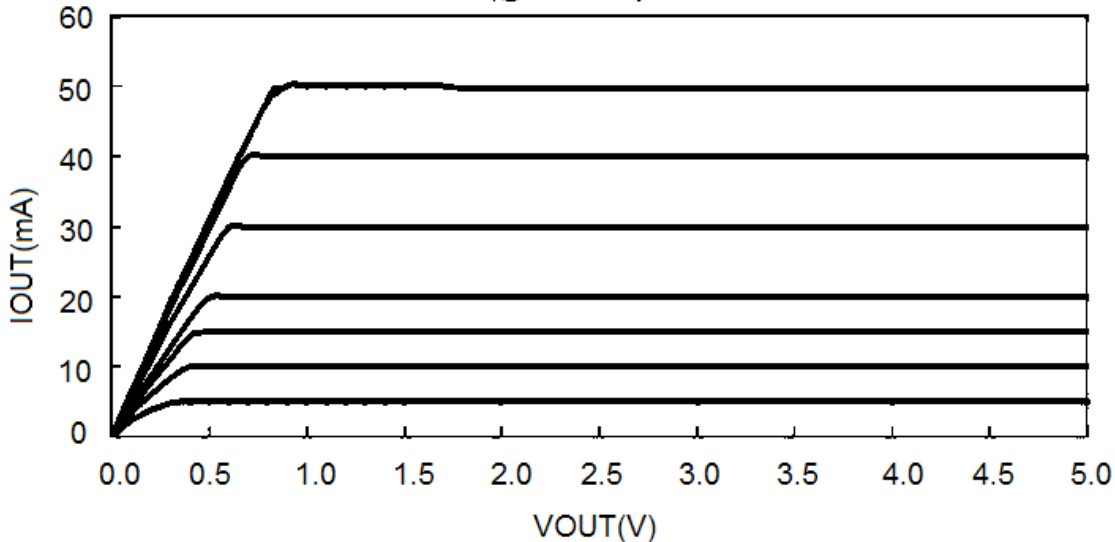
The relationship between I_{OUT} and resistance R_{EXT} is shown as the following figure.



Output Characteristics

The current characteristic of output stage is flat. The output current can be kept constant regardless of the variations of LED forward voltage when $V_{OUT} > 1.0V$.

ME2656 Iout VS. Vout for various Rext
(@Vdd=5.0V)



Power Dissipation

The power dissipation (P_D) of a semiconductor chip is limited by its package and ambient temperature. The maximum allowable power dissipation $P_{D(max)}$ is determined by :

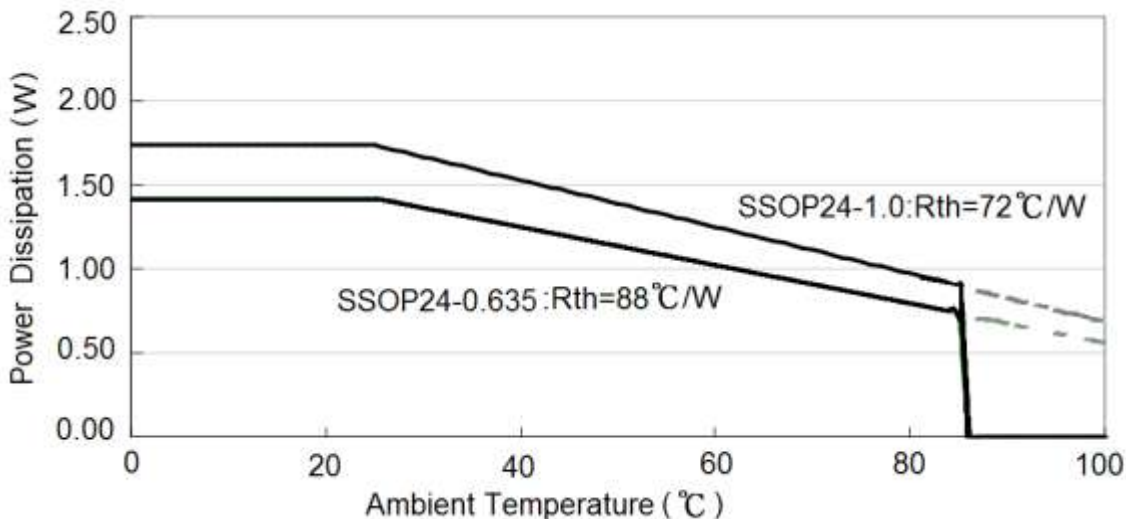
$$P_{D(max)} = (T_{j(max)} - T_a) / R_{th(j-a)}$$

where $T_{j(max)}$: maximum chip junction temperature, usually considered as $150^{\circ}C$

T_a : ambient temperature

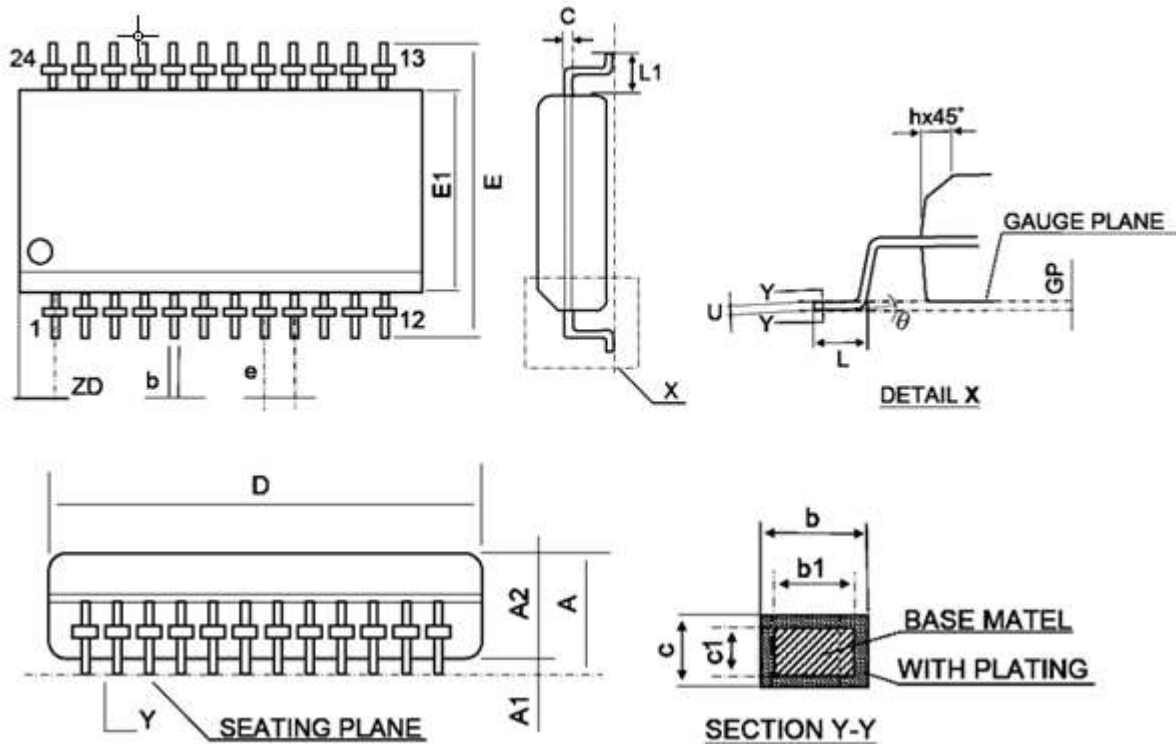
$R_{th(j-a)}$: thermal resistance of the package.

The relationship between $P_{D(max)}$ and T_a is shown as the below figure:



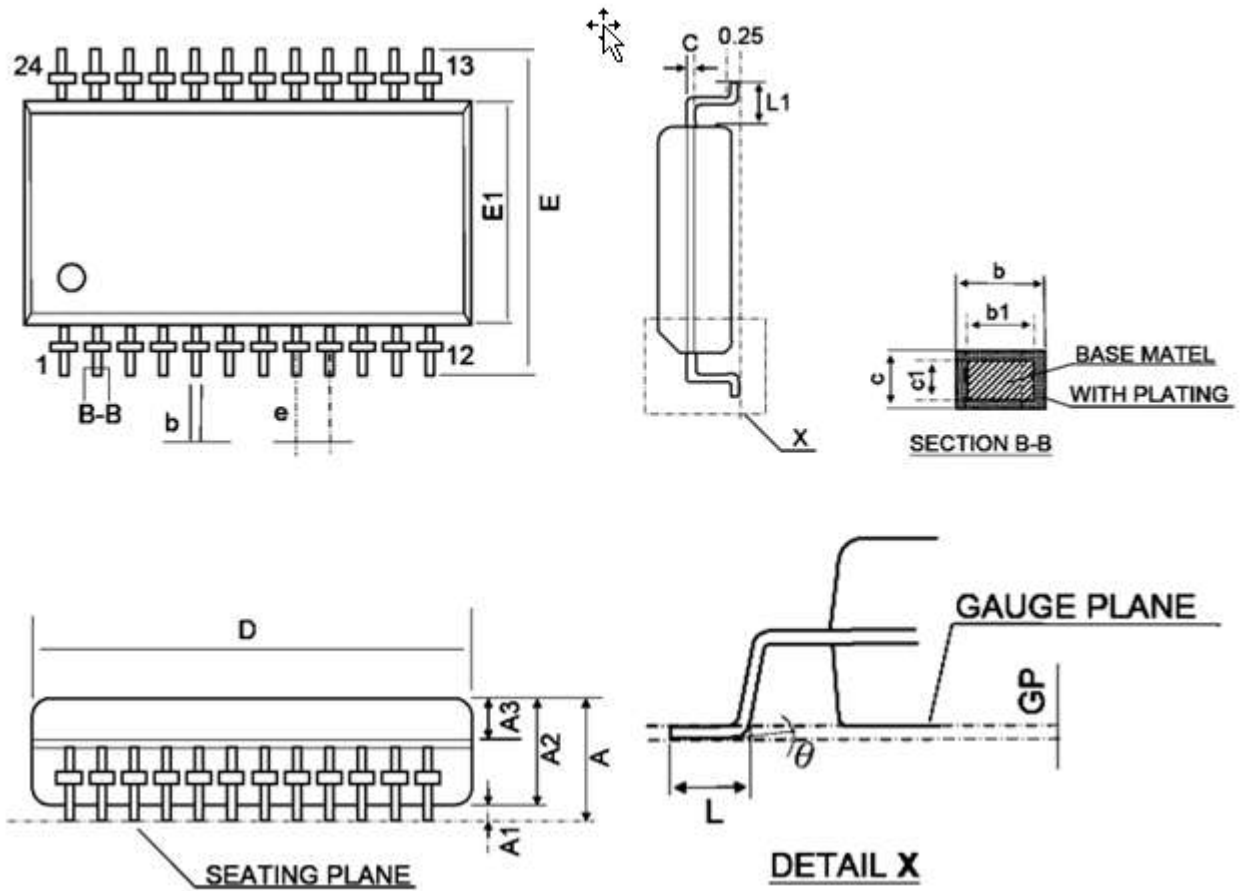
Packaging Information

SSOP24-0.635



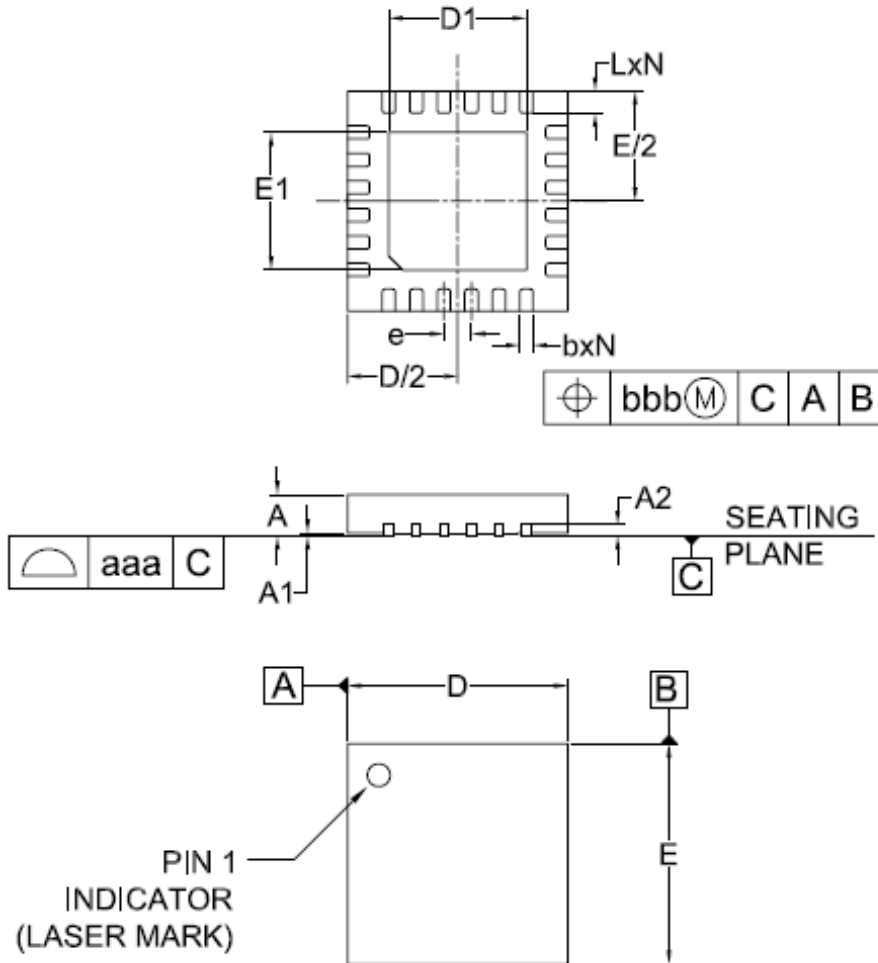
SYMBOL	DIMENSION (mm)			DIMENSION (mil)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.35	1.60	1.75	53	63	69
A1	0.10	0.15	0.25	4	6	10
A2			1.50			59
b	0.20		0.30	8		12
b1	0.20	0.254	0.28	8	10	11
c	0.18		0.25	7		10
c1	0.18	0.203	0.23	7	8	9
D	8.56	8.66	8.74	337	341	344
E	5.80	6.00	6.20	228	236	244
E1	3.80	3.90	4.00	150	154	157
e	0.635 BSC			25 BSC		
h	0.25	0.42	0.50	10	17	20
L	0.40	0.635	1.27	16	25	50
L1	1.00	1.05	1.10	39	41	43
ZD	0.838 REF			33 REF		
Y			0.10			4
θ	0°		8°	0°		8°

SSOP24-1.0



SYMBOL	DIMENSION (mm)			DIMENSION (mil)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	2.20	-	-	87
A1	0.10	0.20	0.30	4	8	12
A2	1.60	1.80	2.00	63	71	79
A3	0.62	0.82	0.92	24	32	36
b	0.39	-	0.47	15	-	19
b1	0.38	0.40	0.43	15	16	17
c	0.15	-	0.20	6	-	8
c1	0.14	0.15	0.16	5.5	6	6.5
D	12.80	13.00	13.20	504	512	520
E	7.70	7.90	8.10	303	311	319
E1	5.80	6.00	6.20	228	236	244
e	1.00 BSC			39 BSC		
L	0.35	0.45	0.55	14	18	22
L1	0.95 BSC			37 BSC		
θ	0°	-	8°	0°	-	8°

QFN24L-4*4-0.5



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	TYP	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A2	0.153	0.203	0.253
b	0.18	0.24	0.30
D	3.90	4.00	4.10
D1	2.40	2.50	2.60
E	3.90	4.00	4.10
E1	2.40	2.50	2.60
e	0.50BSC		
L	0.35	0.40	0.45
N	24		
aaa	0.08		
bbb	0.10		

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