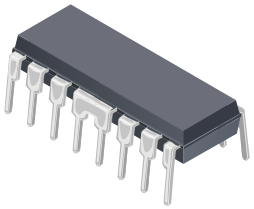
Device Comparisons of A3955 and A4975

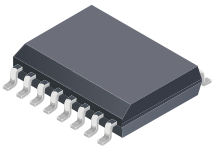
The Allegro® A4975 is intended as the "next generation" A3955. The most notable design upgrade is the transition from bipolar to DMOS technology. DMOS offers smaller geometries, higher power densities and better switching performance than bipolar technologies.

As a result of these upgrades some parameters have changed which may require BOM changes. In most applications only the sense resistor and REF voltage need to be changed. For customers who are using the A3955 and must convert to the A4975 this document shows what changes need to be made to existing circuits in order to use the new device in a similar way.

The data shown here is for reference only. Refer to the datasheets of the individual devices for parameters and detailed functional descriptions. If data in this document does not match the associated device datasheet, then please be aware that the datasheet is the governing specification document in all cases.



Package B, 16-pin DIP with exposed tabs



Package LB, 16-pin SOIC with internally fused pins

Figure 1. Both the A4975 and the A3955 are provided in the 16-pin DIP (B) and 16-pin SOIC (LB) packages, shown here (not to scale).

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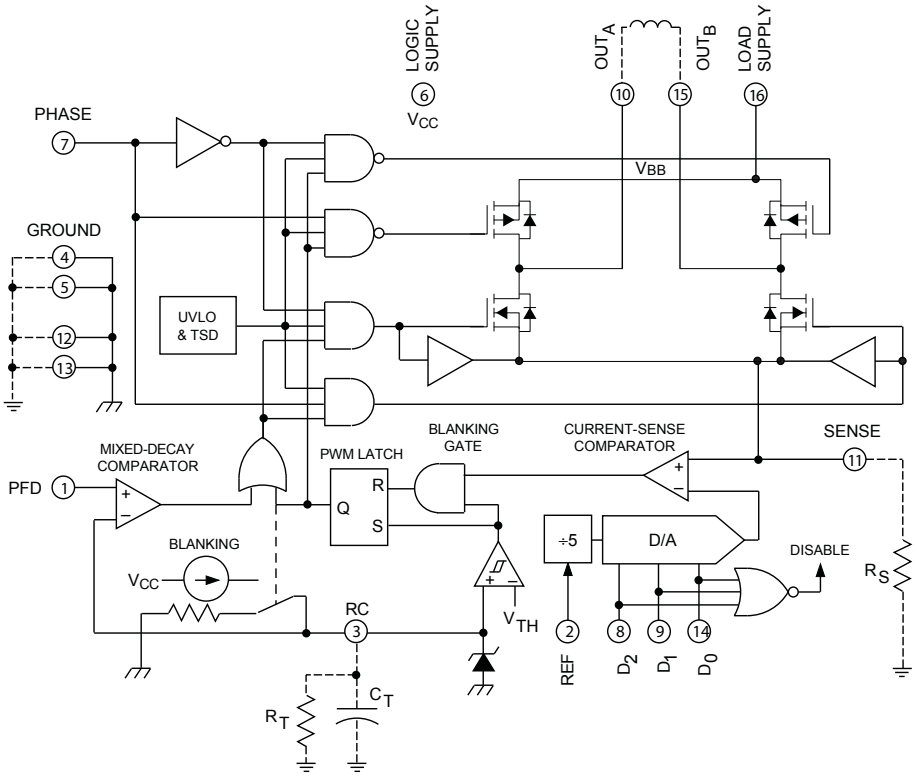
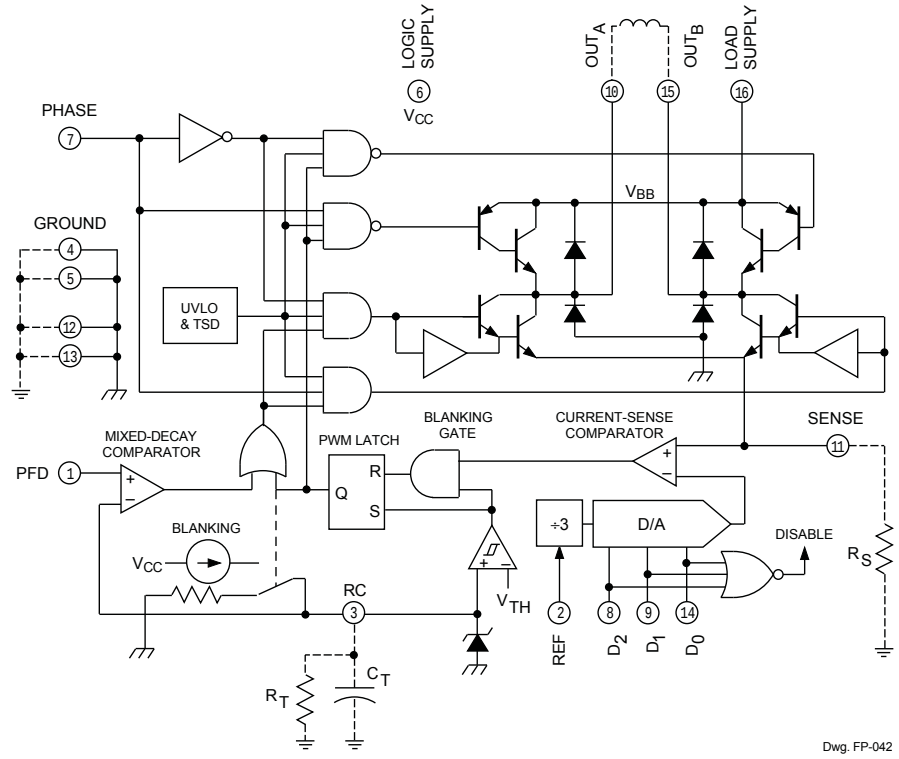
Functional Block Diagrams

A4975



A3955



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Absolute Maximum Ratings

The V_{SENSE} absolute maximum rating has changed from the A3955 to the A4975. The differences are shown in table 1.

V_{SENSE} Range

The absolute maximum voltage on the SENSE pin has been reduced from 1 V (V_{CC} = 5 V) for the A3955 down to 500 mV for the A4975. This makes it necessary for some customers to reduce the size of the current sensing resistor, R_{SENSE}, so that under maximum load current the voltage on the SENSE pin does not exceed 500 mV.

Reference Voltage and Current Regulation

Current regulation is controlled via the voltage on the REF pin, the selected sense resistor, and the DAC settings. The reference voltage passes through a divider before it is compared to the voltage on the SENSE pin. When the sense voltage reaches the reference voltage level, the PWM latch is tripped.

V_{REF} Range

The A3955 has an internal divider equal to 3. This divider was increased to 5 in the A4975. As a result the voltage applied to the REF pin will result in a different output current.

The new maximum I_{TRIP} formula (DAC set to 100%) is:

$$I_{TRIP} \approx V_{REF} / (5 \times R_{SENSE}) \quad (1)$$

R_{SENSE} Selection

As noted above, the maximum allowable V_{SENSE} voltage is decreased from 1 V to 500 mV. When calculating the value for R_{SENSE} the upper limit is defined by the maximum load current and the maximum allowable sense voltage. For example, if 1 A load current is required, the largest sense resistor that can be used is calculated as:

$$R_{SENSE}\,(max) = 500\,(mV) / 1\,(A) = 0.5\,(\Omega) \quad (2)$$

This results in maximum sense resistor of 0.5 Ω. Picking a value slightly lower will provide a guard band for resistor tolerances.

V_{SAT} versus $R_{DS(on)}$

One of the largest differences between the A3955 and the A4975 is the change from bipolar to DMOS topology. This results in significant improvements to die size. The A4975 bridge is made with a P-channel high side and an N-channel low side.

$R_{DS(on)}$ changes significantly with temperature, increasing as temperature rises. For every 100°C rise, $R_{DS(on)}$ increases by a factor of 1.6 times. The A4975 $R_{DS(on)}$ is specified for V_{BB} down to 8 V. For V_{BB} less than 8 V, $R_{DS(on)}$ will be higher (see table 2).

Table 1. Absolute Maximum Ratings Comparison

Characteristic	Symbol	Notes	Rating		Unit
			A4975	A3955	
Sense Voltage	V_{SENSE}		0.5	1.0	A

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Voltage Drop

Bipolar devices are defined by V_{CE} but DMOS devices are defined by $R_{DS(on)}$. The voltage drop across the A4975 bridge is a function of current and the $R_{DS(on)}$ at the specific junction temperature. In order to make the change from the A3955 to the A4975 as transparent as possible the $R_{DS(on)}$ of the source plus sink drivers was selected to have similar voltage drops under similar load conditions. Tables 2 and 3 compare the A3955 bipolar bridge and the A4975 DMOS bridge.

Note that the voltage drop across the A4975 bridge at 1.5 A is 1.5 V. At first glance the performance appears better than the A3955 which would have the same voltage drop at 0.85 A output current. The difference is that the $R_{DS(on)}$ in the A4975 increases with increasing temperature, resulting in a larger voltage drop at higher temperatures. Assuming an operating temperature rise of 100°C above ambient, the expected $R_{DS(on)}$ would be 1.6 Ω, resulting in a total voltage drop of 2.4 V at 1.5 A. A total drop of 2.4 V at operating temperature is close to the 2.6 V drop across the A3955 at the same output current.

Thermals

As stated previously, the A4975 utilizes MOS technology for the output transistors, as opposed to the bipolar transistors of the A3955. The A4975 was found to run cooler than the A3955 when both were run with V_{CC} = 5 V and V_{BB} = 24 V (see figure 2). The A4975 does run hotter as V_{BB} is reduced, but still runs cooler than the A3955 at 1 A output current (see figure 3).

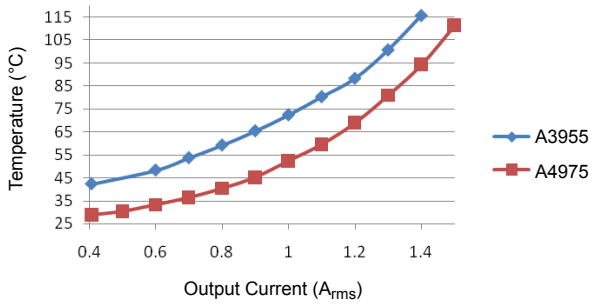

Figure 2. Temperature versus Output Current

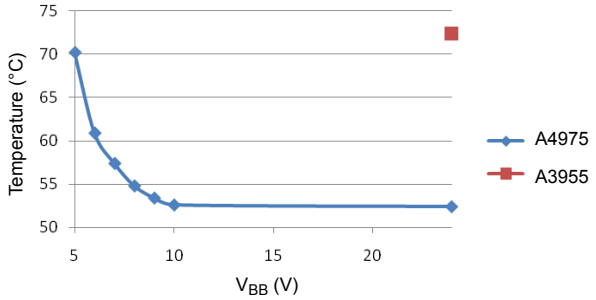

Figure 3. Temperature versus Load Supply Voltage

Table 2. A4975 Output Resistance (DMOS Bridge)

Characteristic	Symbol	Test Conditions	Limits			Unit
			Min.	Typ.	Max.	
Output On Resistance	$R_{DS(on)}$	Total sink and source, I_{OUT} = 1.5 A, V_{BB} > 8 V, T_J = 25°C	–	1	1.4	Ω

Table 3. A3955 Output Saturation (Bipolar Bridge)

Characteristic	Symbol	Test Conditions	Limits			Unit
			Min.	Typ.	Max.	
Output Saturation Voltage	$V_{CE(SAT)}$	Source, I_{OUT} = –0.85 A	–	1.0	1.2	V
		Source, I_{OUT} = –1.5 A	–	1.3	1.5	V
		Sink, I_{OUT} = 0.85 A	–	0.5	0.6	V
		Sink, I_{OUT} = 1.5 A	–	1.3	1.5	V

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Minimum Regulated Output Current

The minimum regulated output current is determined by grounding the reference input while driving a load. The current cannot get down to zero due to the blanking time. With RC values of 30 kΩ and 1000 pF, the A4975 is able to regulate to a lower current, 160 mA, than the A3955 can. The A3955 can only regulate down to 260 mA. See figures 4 and 5.

Input Logic Levels

The A4975 uses CMOS type inputs with thresholds that vary with the logic supply voltage. The A3955 has TTL inputs. At higher logic supply voltages the logic high requirement may not be guaranteed. See table 4.

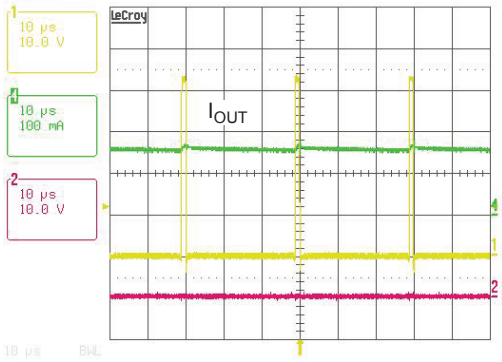

Figure 4. A4975 regulation of I_{OUT} (green trace)

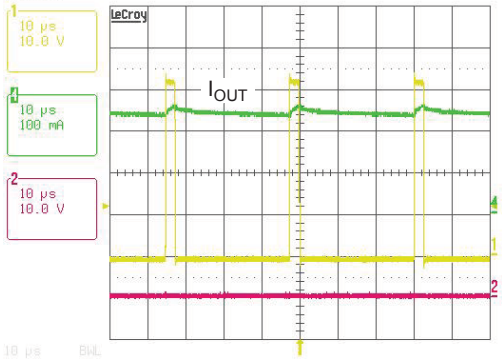

Figure 5. A3955 regulation regulation of I_{OUT} (green trace)

Table 4. V_{IN} Comparison

Characteristic	Symbol	Test Conditions	Limits				Unit
			A4975		A3955		
			Min.	Max.	Min.	Max.	
Logic Input Voltage	$V_{IN(1)}$		V_{CC}× 0.55	–	2.0	–	V
	$V_{IN(0)}$		–	V_{CC}× 0.27	–	0.8	V

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