Temperature Compensating Gamma Trimster™ ATT3209

FEATURES

- 9 Programmable Buffered Gamma Correction Outputs ($V_{GMA}0 – V_{GMA}8$)
  - V_{GMA} Output Range 0 to 14V
  - V_{GMA} Output Accuracy Better Than 1% of A_{VDD} Reference
  - V_{GMA} Output Drive > 100µA
- Nonvolatile Storage of 32 Gamma Reference Providing
  - Dynamic Gamma Correction and Gamma Correction Based on Programmed Temperature Profiles
- 2 Programmable Buffered V_{COM} Outputs
- In System Programmability
- Digital Programming Interface

APPLICATIONS

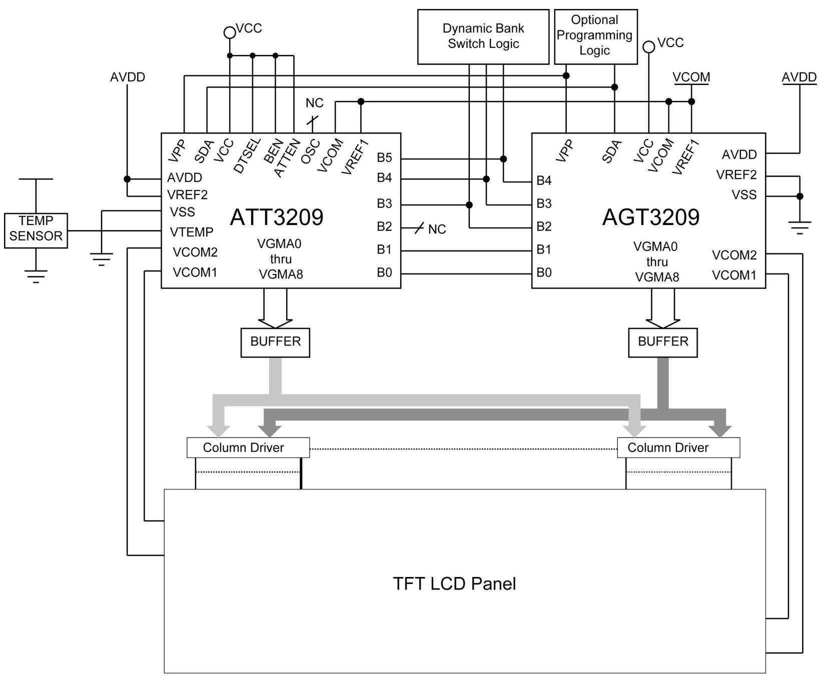
- Yield Improvement through Gamma Programming at Test
- Simple Implementation of Dynamic Gamma Compensation
- LCD Panel Color Calibration
- Optimized Temperature Dependent Gamma Correction

DESCRIPTION

The ATT3209 is a programmable gamma reference that is designed to address gamma correction in high-resolution LCD panels.

The gamma voltage outputs are programmable with their individual output values saved in a nonvolatile analog storage cell. The storage cells are arranged in a 9 x 32 array allowing thirty-two gamma correction profiles to be stored. Depending upon the application requirements the ATT3209 is configured to provide either two or three temperature compensated Bank Select outputs that would be used to drive the respective Bank Select inputs of the AGT3209 Gamma Trimster.

In addition to the V_{GMA} outputs there are two programmable V_{COM} outputs providing independent multiple V_{COM} trim points to minimize flicker on the LCD panel.



Typical Application

ABSOLUTE MAXIMUM RATINGS

Over operating free-air temperature range unless otherwise specified (1)

PARAMETER	Max	Unit
Analog Supply, A_{VDD} (2)	14.5	V
Delta $V_{REF}1$ and $V_{REF}2$, Delta V_{REF}	9	V
Programming Supply V_{PP}	14	V
Digital Supply V_{CC}	5	V
Continuous Total Power Dissipation		mA
Operating Free-air Temperature Range, T_A	-25 to +125	ºC
Maximum Junction Temperature, T_J	150	ºC
Storage Temperature, T_{STG}	-65 to 150	ºC
Lead Temperature 1.6mm (1/16 inch) from Case for 10 seconds	260	ºC

(1) Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

(2) All voltage values are with respect to V_{SS}.

DISSIPATION RATING TABLE

PACKAGE TYPE	PACKAGE DESIGNATOR	$THETA_{JC}$	$THETA_{JA}$
32 Lead MLF (QFN)		1.1°C/W	34°C/W

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Typ	Max	Units
T_A	Operating Free air Temperature	0		85	°C
A_{VDD}	Analog Supply Voltage (with respect to V_{SS})	10	13	14	V
V_{PP}	Programming Supply Voltage (with respect to V_{SS})	9	10	14	V
V_{CC}	Digital Supply Voltage (with respect to V_{SS})	2.7	3.3	3.6	V

ELECTRICAL CHARACTERISTICS

Operating over free-air temperature range, V_{PP} = 9V to 14V, V_{CC} = 3.3V, A_{VDD} = 14V

SUPPLIES						
Symbol	**Parameter**	**Test Condition**	**Min**	**Typ**	**Max**	**Units**
I_{AVDD}	Analog Supply Current	V_{GMA}0 thru V_{GMA}8 = Nominal Setting V_{REF}1/V_{REF}2 Delta ≤ 9V		9		mA
I_{CC}	Digital Supply Current Active	Vcc = 3.3V, B0-B5, SDA, V_{PP} = GND		300		µA
ANALOG CHARACTERISTICS						
Symbol	**Parameter**	**Test Condition**	**Min**	**Typ**	**Max**	**Units**
V_{COM}	VCOM1, VCOM2 Output Voltage, Low	I_O = 100µA	V_{COM}-1V	VCOM in	V_{COM}+1V	V
V_{PROG}	VGMA Programming Precision		-5	±2.5	+5	mV
V_{DRIFT}	VGMA Drift	10 Years @ 70 deg. C.	-5		5	mV
V_{STAB}	VGMA Stability over operating conditions		-5		5	mV
V_{REF} Delta1	V_{REF}1-V_{REF}2				9	V
V_{REF} Delta2	V_{REF}2-V_{REF}1				9	V

DC OPERATING CHARACTERISTICS						
Symbol	**Parameter**	**Test Condition**	**Min**	**Typ**	**Max**	**Units**
V_{IL}	SDA, B0-B5 Input Low Voltage				V_{CC}x.20	V
V_{IH}	SDA, B0-B5 Input HighVoltage		V_{CC}x0.8			V
t_{DLY}	Delay B0-B5 change to VGMA output					ms

Note: Detailed programming information is available from Alta Analog in the ATT3209 Addendum.

Nominal V_{GMA} is dependent upon $V_{REF}1$ and $V_{REF}2$ and is calculated as follows: **R_{RATIO}x(V_{REF}2-V_{REF}1)+V_{REF}1**						
FIRST ORDER GAMMA CURVE VALUES						
Symbol	**Parameter**	**Test Condition**	**Min. Trim**	**Nom**	**Max Trim**	**Units**
$V_{GMA}0$	Gamma 0 Output	$R_{RATIO}0$ = 0.909 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	12.363	13.363	14.363	V
$V_{GMA}1$	Gamma 1 Output	$R_{RATIO}1$ = 0.660 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	10.618	11.618	12.618	V
$V_{GMA}2$	Gamma 2 Output	$R_{RATIO}2$ = 0.525 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	9.672	10.672	11.672	V
$V_{GMA}3$	Gamma 3 Output	$R_{RATIO}3$ = 0.393 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	8.754	9.754	10.754	V
$V_{GMA}4$	Gamma 4 Output	$R_{RATIO}4$ = 0.319 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	8.231	9.231	10.231	V
$V_{GMA}5$	Gamma 5 Output	$R_{RATIO}5$ = 0.264 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	7.849	8.849	9.849	V
$V_{GMA}6$	Gamma 6 Output	$R_{RATIO}6$ = 0.180 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	7.262	8.262	9.262	V
$V_{GMA}7$	Gamma 7 Output	$R_{RATIO}7$ = 0.024 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	6.168	7.168	8.168	V
$V_{GMA}8$	Gamma 8 Output	$R_{RATIO}8$ = 0 $V_{REF}2$ = 14V, $V_{REF}1$ = 7V	6	7	8	V
$V_{GMA}9$	Gamma 8 Output	$R_{RATIO}8$ = 0 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	6	7	8	V
$V_{GMA}10$	Gamma 7 Output	$R_{RATIO}7$ = 0.024 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	5.832	6.832	7.832	V
$V_{GMA}11$	Gamma 6 Output	$R_{RATIO}6$ = 0.180 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	4.74	5.74	6.74	V
$V_{GMA}12$	Gamma 5 Output	$R_{RATIO}5$ = 0.264 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	4.152	5.152	6.152	V
$V_{GMA}13$	Gamma 4 Output	$R_{RATIO}4$ = 0.319 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	3.767	4.767	5.767	V
$V_{GMA}14$	Gamma 3 Output	$R_{RATIO}3$ = 0.393 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	3.249	4.249	5.249	V
$V_{GMA}15$	Gamma 2 Output	$R_{RATIO}2$ = 0.525 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	2.325	3.325	4.325	V
$V_{GMA}16$	Gamma 1 Output	$R_{RATIO}1$ = 0.660 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	1.38	2.38	3.38	V
$V_{GMA}17$	Gamma 0 Output	$R_{RATIO}0$ = 0.909 $V_{REF}2$ = 0V, $V_{REF}1$ = 7V	0	0.637	1.637	V

INPUT / OUTPUT FUNCTION DESCRIPTION			
Name	**Description**	**Value Range**	**Function**
V_{DD}	Digital Supply Input	3V to 3.3V	
A_{VDD}	Analog Supply	10-14 V	
$V_{GMA}0$-$V_{GMA}8$	Analog Outputs	$V_{REF}1$ to $V_{REF}2$	Analog Gamma Output Channels
B0 – B2	Bank Select	I/O's	During normal ATT3209 operation the B0 – B2 pins are outputs that output the result of the temperature profile logic.
B3 – B5	Bank Select	CMOS inputs	The B3-B5 inputs are the dynamic bank select inputs. The state of DTSEL determines whether the banks are arranged as 8 banks of 4 profiles or 4 banks of 8 profiles.
$V_{REF}1$/ $V_{REF}2$	Input Reference voltages	0-14 Volts	Reference voltages for generating VGMA outputs.
A_{OUT}	Analog Output		Outputs the current value of the selected channel of the selected bank during programming
V_{PP}	Programming Voltage & Serial Clock	10-14Volts V_{IL} to V_{IH}	Dual Function: Programming mode - Input for VPP pulses for adjusting the VGMA output values. Digital mode – clock input for serial interface.
DTSEL	Temperature Profile Select	CMOS Input	Internally this input tied to ground through a 100K ohm resistor. The state of DTSEL selects the five B inputs that will be used by the ATT3209. DTSEL low configures the array 4 banks of 8 temperature profiles. DTSEL high configures the array 8 dynamic banks of 4 temperature profiles.
VTEMP	Temperature sensor input		Internally this input tied to ground through a 100K ohm resistor. Temperature sensor input to the programmable temperature profile array.
ATTEN	ATT enable input	CMOS input	Internally this input tied to ground through a 100K ohm resistor. This input should be tied directly to VCC for normal device operation.
OSC	Oscillator output		OSC is an output used during test and will be a no–connect during normal device operation.
BEN	Bank ENABLE		

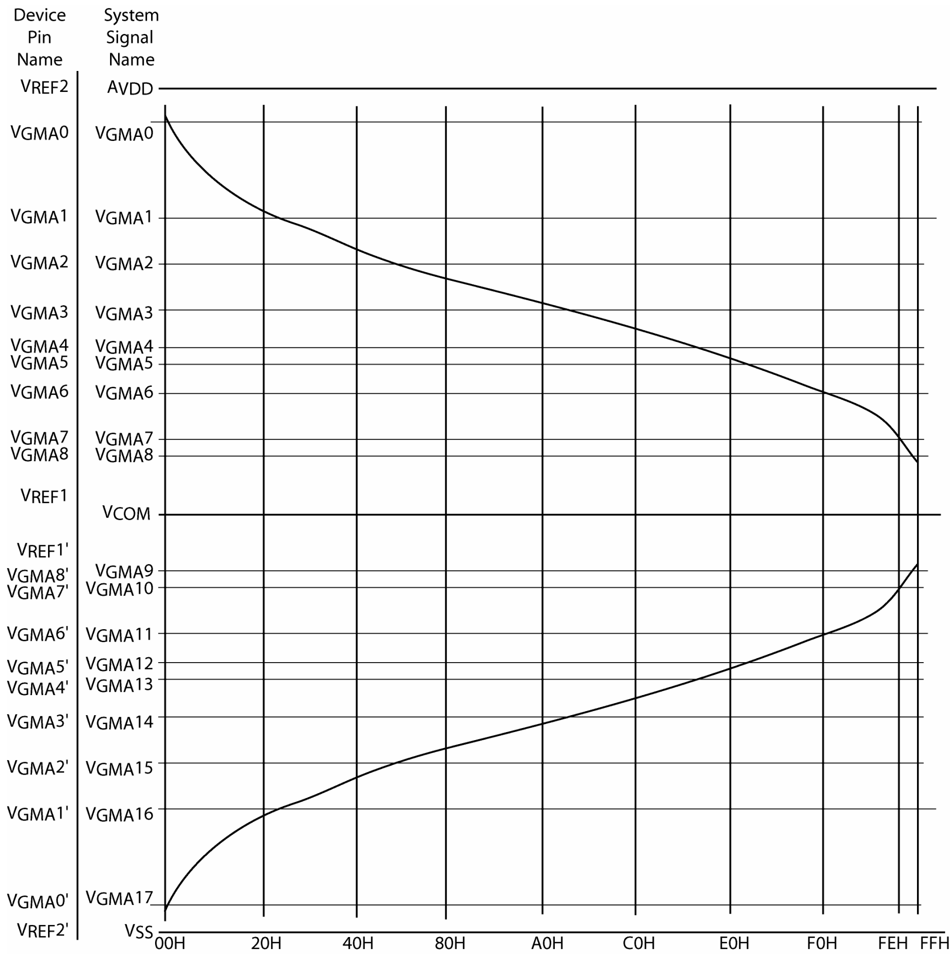


Figure 1: Typical gamma correction curve.

FUNCTIONAL DESCRIPTION

The ATT3209 is a programmable gamma correction reference device with high drive output buffers. The device can be easily programmed prior to or during any phase of the LCD-panel manufacturing process. The gamma reference voltages are programmed and saved on nonvolatile storage cells.

VGMA

Figure 1 shows a typical gamma correction curve with 18 reference points. The ATT3209 V_{GMA} outputs can be programmed to match any point on the curve. The 9 outputs ($V_{GMA}0$ through $V_{GMA}8$) approximate one half of the curve.

Internal to the ATT3209, between $V_{REF}1$ and $V_{REF}2$, there is a resistor string along which are tap points that approximate a first order gamma curve. The nominal V_{GMA} reference voltages are a ratio of the voltage differential between the V_{REF} inputs and are calculated by the following:

$$R_{RATIO} * (V_{REF}2 - V_{REF}1) + V_{REF}1.$$

The R_{RATIO} values are shown in Table 1. The nominal V_{GMA} value can be trimmed ±1V by programming, with the final value being stored on a nonvolatile storage cell.

Because the resistor string is fixed to approximate one half of the gamma curve the V_{REF} inputs are reversible with respect to which is more positive. As an example: in order to generate the points on the gamma curve shown in Figure 1the ATT3209 generating $V_{GMA}0$-$V_{GMA}8$ would have its V_{REF} 1 tied to V_{COM} and $V_{REF}2$ tied to A_{VDD}. The ATT3209 generating $V_{GMA}9$-$V_{GMA}17$ would have its $V_{REF}1$ tied to V_{COM} and $V_{REF}2$ tied to V_{SS}. The V_{GMA} buffers can drive the outputs to within 200mV of A_{VDD} and V_{SS}.

VGMA	R_{RATIO}
$V_{GMA}0$	0.909
$V_{GMA}1$	0.660
$V_{GMA}2$	0.525
$V_{GMA}3$	0.393
$V_{GMA}4$	0.319
$V_{GMA}5$	0.264
$V_{GMA}6$	0.180
$V_{GMA}7$	0.024
$V_{GMA}8$	0.000

Table1: R_{RATIO} Table.

Dynamic Gamma Compensation

In many applications, especially those which involve the display of video information such as movies or television programming, it is desirable to be able to change the gamma curve based on the active frame information. The ATT3209 stores thirty-two individual gamma curves that can be dynamically 'switched in' by the panel's timing controller in response to the frame data.

Temperature and Gamma Profiles

The ATT3209 has two nonvolatile arrays. One is the temperature profile. This array stores up to eight programmable voltage references against which the VTEMP input is compared. As the VTEMP changes and transitions through the preset temperature profile the low order bank select (B0:B1 or B0:B2) will change, effectively selecting a new gamma profile optimal for the current temperature. These signals used internally will also be output on the B0:B2 pins.

The gamma profile array is comprised of thirty-two (32) banks of nine (9) programmable gamma outputs. The active bank, or profile, is selected by 5 of the 6 bank select inputs. The active bank select inputs are determined by the state of DTSEL as shown in Table 2.

ATT3209 Active and Inactive Bank Pins						
DTSEL	B0	B1	B2	B3	B4	B5
VSS	A	A	A	A	A	IA
VCC	A	A	IA	A	A	A

Table 2. Active Bank Select pins.

When DTSEL is tied low, the ATT3209 is configured with B0:B2 being used internally and as active outputs reflecting the temperature input, and B3 & B4 are used as the dynamic gamma inputs.

When DTSEL is tied high, the ATT3209 is configured with B0 & B1 being used internally and as active outputs reflecting the temperature input, and B3:B5 are used as the dynamic gamma inputs.

ATT3209 and AGT3209

The ATT3209 is designed to work in conjunction with the AGT3209. When they are paired the, the bank select pins are connected as shown in table 3.

		AGT3209 Pins				
		B0	B1	B2	B3	B4
ATT3209 DTSEL	VSS	B0	B1	B2	B3	B4
	VCC	B0	B1	B3	B4	B5

Table 3. Shared pins.

VCOM

The ATT3209 also provides two "trimmable" V_{COM} outputs. The nominal output is equivalent to Panel $A_{VDD}/2$. The V_{COM} output voltage can be trimmed to $A_{VDD}/2$ ±1V. For example; assume a LCD panel with a 14V panel A_{VDD}, then V_{COM} can be trimmed anywhere between 6V and 8V effectively in 8mV increments.

The ATT3209 is easily programmed either by Alta Analog or the end user. It can be programmed as a standalone device in most any test fixture or in-circuit on the assembled LCD-panel.

PROGRAMMING

The programming interface is a set of three inputs plus a digital supply (V_{CC}).

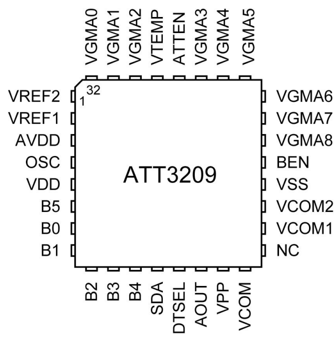
SDA is the serial data input pin used to input instructions to the ATT3209.

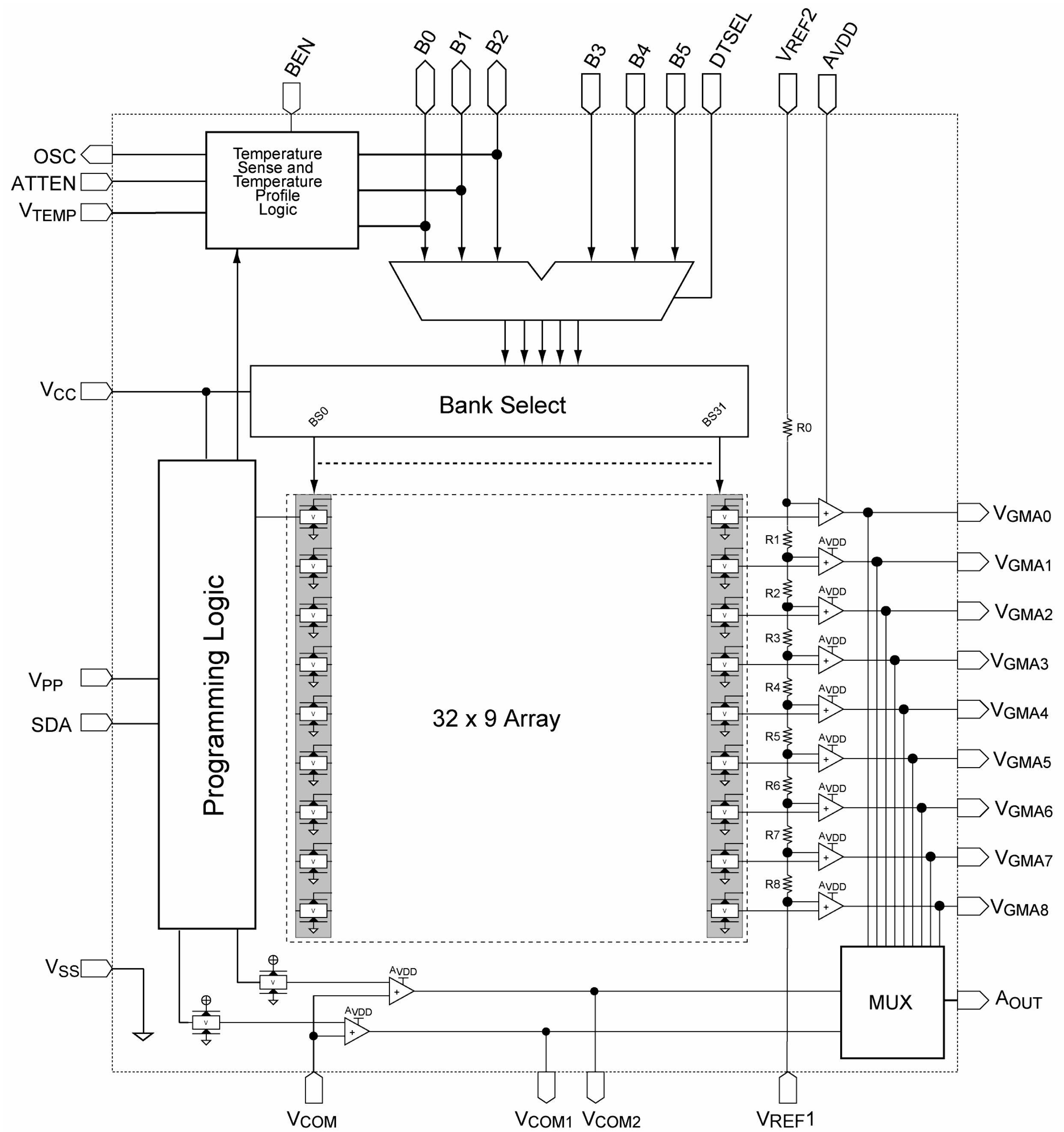
V_{PP} is a dual function pin. It is first used to clock in the serial data stream. Once the instruction has been issued V_{PP} will then be used as the programming voltage input pin.

A_{OUT} is a buffered analog voltage output that reflects the V_{GMA} voltage level of the cell currently being programmed. This output is only used during the programming operation.

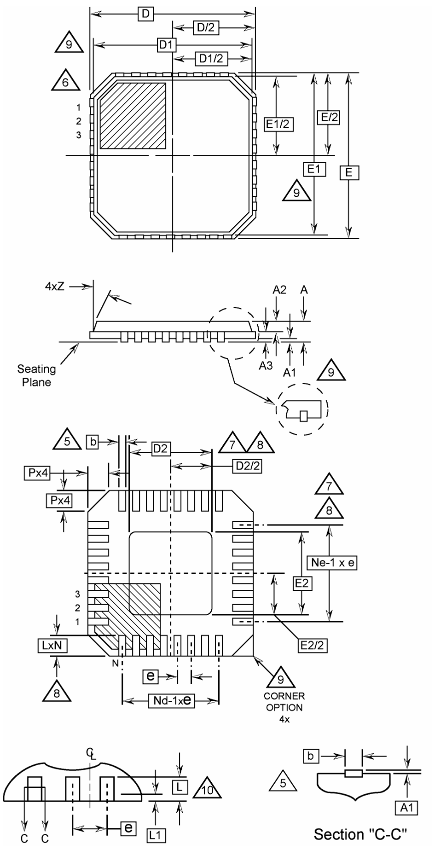
OPERATION

Once the ATT3209 is programmed it will power-up with the V_{GMA} and V_{COM} outputs at their selected (state of B0-B4) program levels.





ATT3209 Functional Block Diagram



32 Lead Quad Flat No-Lead Plastic Package

Symbol	Millimeters Min	Millimeters Nominal	Millimeters Max	Notes
D		5.00 BSC		-
D1		4.75 BSC		8
D2	3.15	3.30	3.45	6,7
E		5.00 BSC		-
E1		4.75 BSC		8
E2	3.15	3.30	3.45	6,8
e		5.00 BSC		-
K	0.25	-	-	-
L	0.30	0.40	0.50	7
L1	-	-	0.15	9
N	32			2
Nd		8		3
Ne		8		3
P	-	-	0.60	8
Z	-	-	12	8

Notes:

1. Dimensioning and tolerances conform to ASME Y145 – 1994.
2. N is the number of terminals.
3. Nd and Ne refer to the number of terminals on each D and E.
4. All dimensions are in millimeters Angles are in degrees.
5. The configuration of pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.
6. Dimensions D2 and E2 are for the exposed pads which provide improved electrical and thermal performance.
7. Nominal dimensions are provided to assist with PCB Land Pattern Design efforts.
8. Features and dimensions D1, E1, P and Z are present when Anvil singulation method is used and not present for saw singulation.
9. Depending on the method of lead termination at the edge of the package, a maximum 0.15mm pull back (L1) may be present. L minus L1 to be equal to or greater than 0.3mm.