



## CSS NVM

## VPP Generator Macro

### EEPROM Support Circuit for Transoma Medical

#### General Description

This support circuit supplies the high voltage (VPP) required to program EEPROM macro cells. It contains a high frequency oscillator, charge pump and voltage regulator. Depending on the system application, high voltage switches can be included so multiple EEPROM blocks can be programmed using one VPP Generator. An optional VPP divider/amplifier may be included to allow the amplitude of VPP to be monitored.

#### Specifications

Process: AMI C5L/F (Double Poly, Double Metal)

Temperature range = 0°C to +50°C

Supply Voltage:

1.5V to 3.3V

Supply Current (VDD = 1.6V):

Standby current < 10nA

Average current ~ 2uA

Output Voltage:

$17.5 \times V_{REF}$  ( $V_{REF}$  is an externally supplied voltage, typically from a bandgap reference)

Output Current (VDD = 1.6V, VPP = 20V):

0.5uA

Approximate Block Size:

VPP Generator ~ 475um x 160um

HV Switch Array (80) ~ TBD x TBD

VPP Generator Requirements:  $I_{REF} \sim 100\text{nA}$ ,  $V_{REF} = 1.122\text{V} \pm 3\%$

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### Pin Descriptions

#### Power Pins

- VDD** Positive supply voltage.
- VSS** Ground.
- VPP** Programming voltage (the output of the VPP Generator)

#### Control Pins

- PROGB** Enables the Generator. (Active low.)
- E/WB** Selects between Erase and Write modes. (Low = Write, High = Erase.)
- ERASES<sub>N</sub>** High voltage control signal required by the NV Register for Erase Mode.
- WRITES<sub>N</sub>** High voltage control signal required by the NV Register for Write Mode.

#### Analog Pins

- I<sub>REF</sub>** Reference current for I<sub>BIAS</sub> signals. (Sink to VSS)
- V<sub>REF</sub>** Reference voltage, typically from a bandgap, used by the VPP Regulator.
- VPP<sub>MON</sub>** Optional output, equal to VPP/20. (Used to monitor the VPP voltage.)

### Operating Modes

- Standby:** Low current, idle mode. All circuits are disabled. Supply current is approximately zero.
  - Program:** The VPP Generator is enabled and provides ~ +20V to the EEPROM.
- A summary of the operating modes is provided in Table 1.

### Operating Mode Table

Mode	Description	PROGB	E/WB	VREF	IREF	ERASES <sub>N</sub>	WRITES <sub>N</sub>	VPP
Standby	Idle Mode (low current)	1	X	X	X	0V	0V	0V
Erase	Erase selected NV Register	0	1	+1.122V	~100 nA	~ +19.5V	0V	~ +19.5V
Write	Write selected NV Register	0	0	+1.122V	~100 nA	~ +19.5V	~ +19.5V	~ +19.5V

Table 1

Notes:

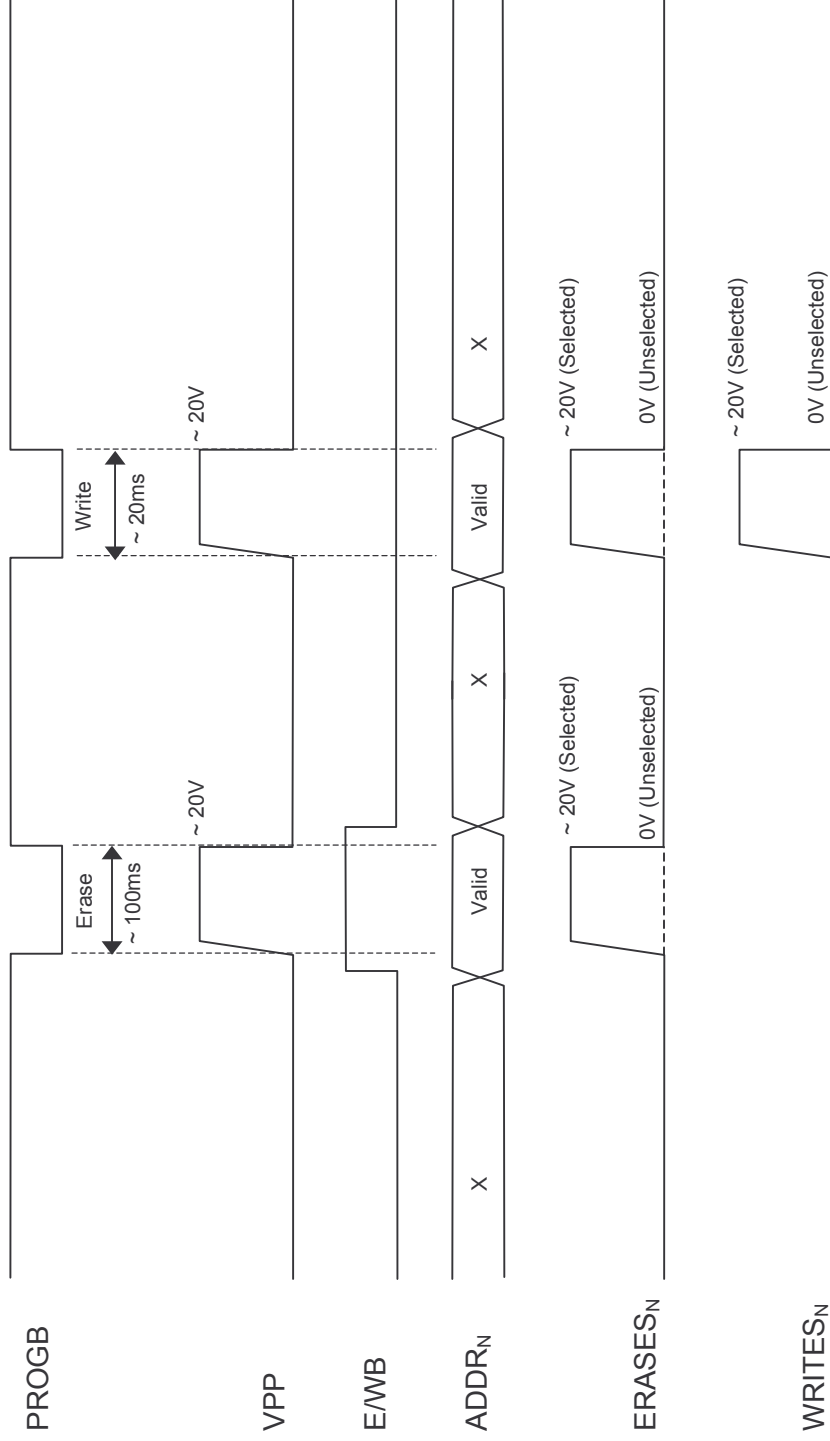
- 1) VPP ~ 17.5 x V<sub>REF</sub>
- 2) There is no DC load on V<sub>REF</sub>. It goes to the gate of a small FET.
- 3) I<sub>REF</sub> determines pumper clock frequency and output current available at VPP.
- 4) The I<sub>REF</sub> input, when VPP is enabled, is connected to a diode configured, N<sub>CH</sub> FET.



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### Timing Diagrams

#### Erase & Write a Selected NV Register



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### Electrical Characteristics (from SPICE)

#### Operating Conditions:

VDD = 1.5V to 1.6V (Typical = 1.58V)

Temperature = 0°C to 50°C (Typical = 37°C)

I<sub>REF</sub> = 100nA ±20%

V<sub>REF</sub> = 1.122V ±3%

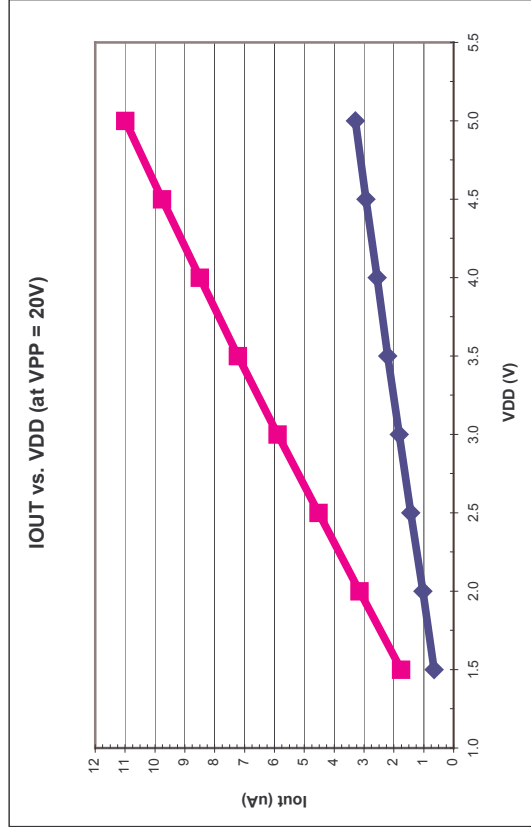
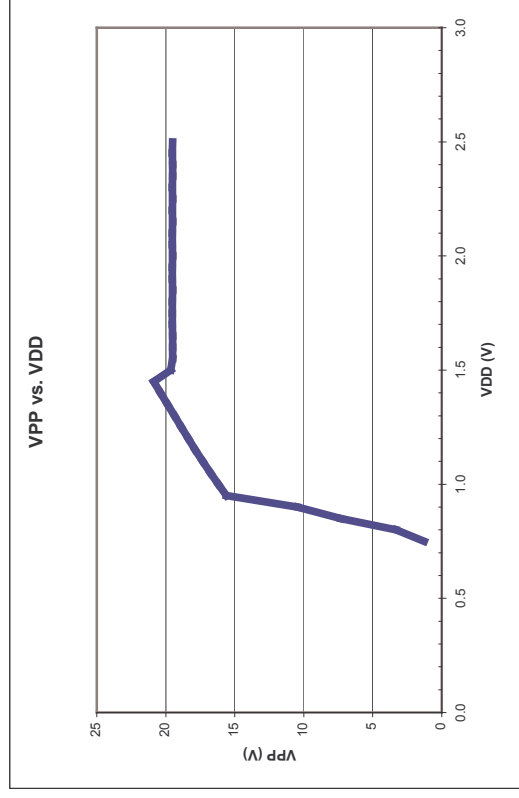
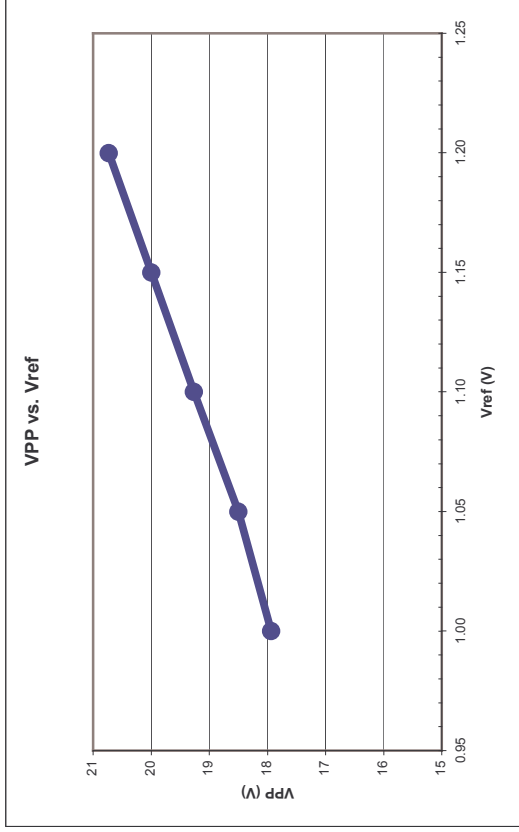
Parameter	Conditions	Minimum	Typical	Maximum	Units
Standby Current	PROGB = 1		< 10	< 10	nA
VDD Active Current (VPP charging)	PROGB = 0, Pumper active		135	200	µA
VDD Active Current (VPP at final level)	PROGB = 0, Pumper inactive		2	3	µA
RC Oscillator Frequency		2.0	3.3	5.0	MHz
VPP Rise Time	Clload = 20pF, VPP = 0V to Regulation	100	175	250	µsec
VPP Regulated Voltage		18.5	19.4	20.0	V

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## Electrical Characteristics (Typical)



Ibias = 2uA (magenta) & 8uA (blue)