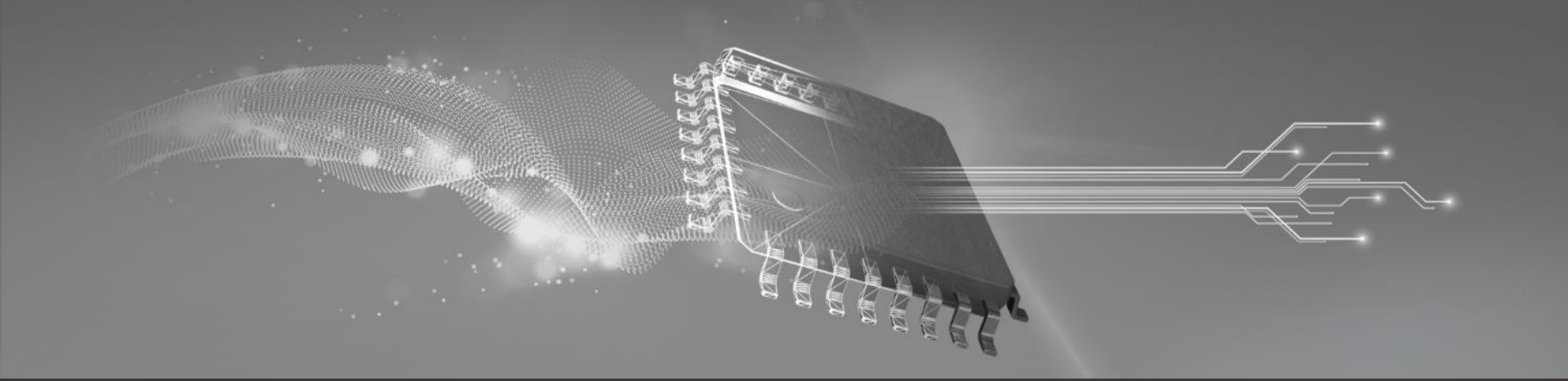
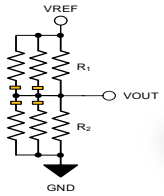
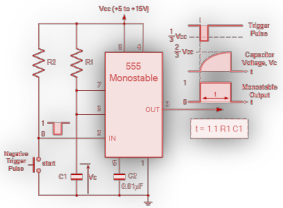


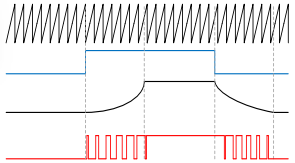
Smart DAC & Smart AFE – A New Building Block with New possibilities

Precision Resistor **555 Timer Upgrade**
(Just By Programming NVM)

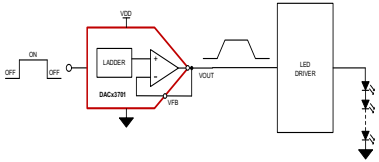




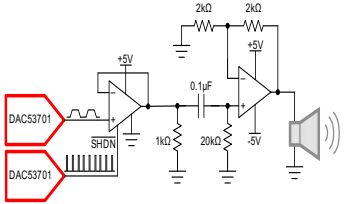
Smart PWM Generator
(Without MCU)



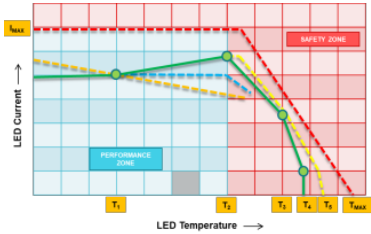
Control with GPIO trigger
(Helps avoid trivial SW)



Medical Alarm
(when SW fails)

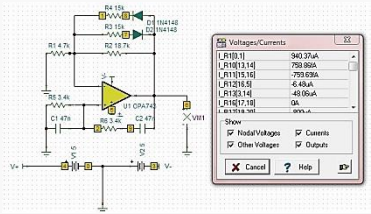
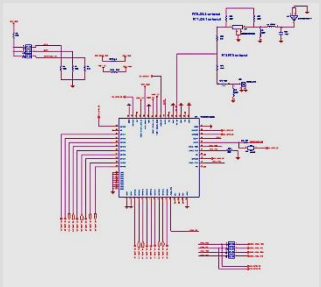


Closed loop control
(No SW)



Texas Instruments

Current day challenges in system design

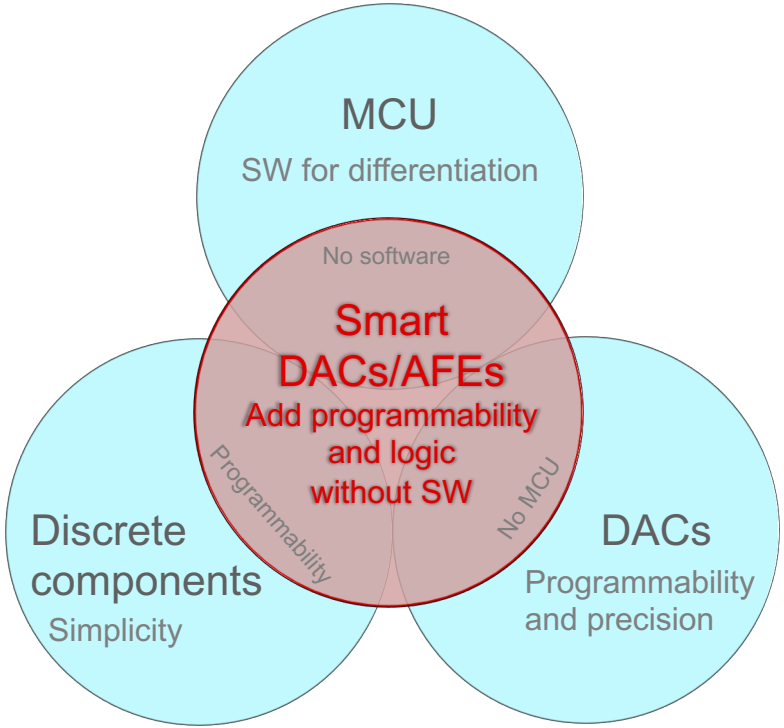
	Design	Pros	Cons
Discrete circuit		• Low Cost • Optimized design	• Difficult to program, configure, scale and reuse • Needs strong analog design expertise • Many components need bigger area
MCU-based circuit		• Manages complexity • Easy to reuse	• Software dependence for simple logic and configuration • Higher R&D time and cost • Software maintenance and certification overhead

Add programmability

No conventional solution exists

Eliminate s/w overhead

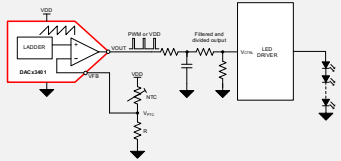
Why Smart DACs and Smart AFEs



Analog design is fun. Adding programmability is not … **Now you have Smart DACs and Smart AFEs**

What is a Smart DAC? - control w/o software

DAC53701

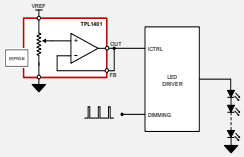


LED dimming

PWM

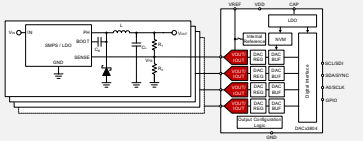
NVM

TPL1401



Programmable current limit

DAC53204

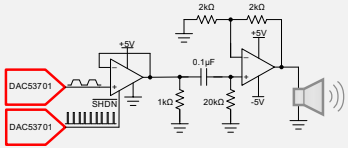


Hassle-free voltage margining

Hi-Z

DAC

DAC53701

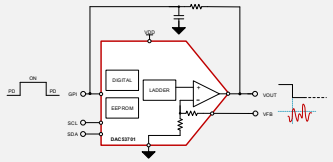


Alarm with GPI Trigger

GPI Trigger

Comparator

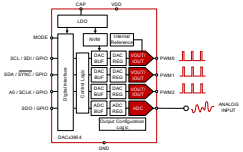
DAC53701



Latching comparator

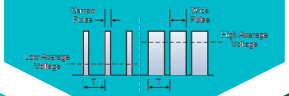
What is Smart AFE? - sensing and control (w/o software)

AFE539B4-Q1



Analog to PWM

PWM



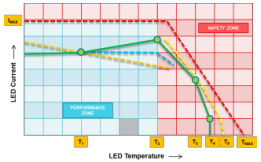
NVM

Hi-Z

DAC

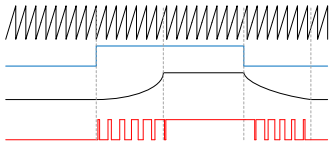
ADC

AFE539A4-Q1



IF-THIS-THEN-THAT control

DAC53902-Q1

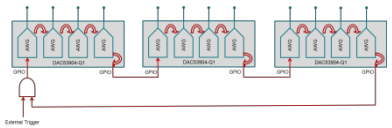


Logarithmic fade-in fade-out

GPI Trigger

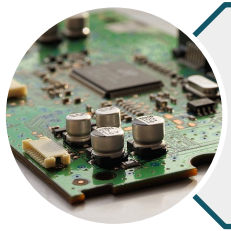
State Machine

DAC53904-Q1



Cascaded animation

The Smart DAC Advantage



Add Programmability to Analog design without software

Delighted hardware engineer

Simplify software by removing SW dependence in HW control

Delighted software engineer

Reduce R&D and Product Cost

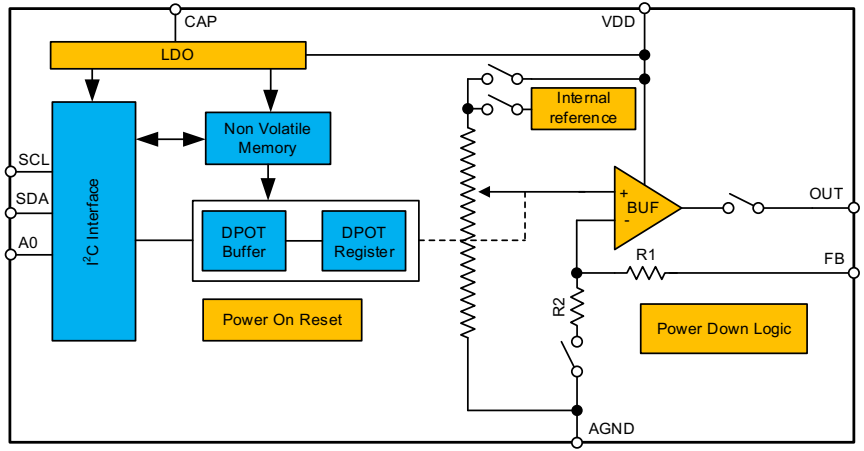
Delighted program manager

An example Smart DAC

- Internal reference with 1% accuracy
- User programmable Nonvolatile memory
- Buffered wiper for improved load regulation
- Hi-Z or programmable start-up using NVM
- Lock bit to protect accidental writes to register or NVM
- I2C interface

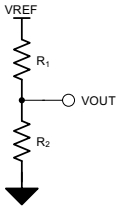
- Wide Temperature range: -40°C to +125°C
- Small package WQFN-8 (2x2)

TPL1401



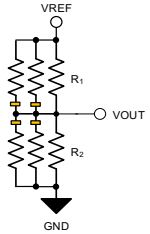
Generating a DC set-point

Resistor divider



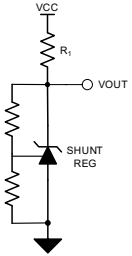
- Simple circuit
- No programmability
- No load regulation
- External reference

LASER trimming



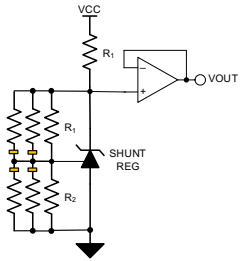
- Limited programmability
- No load regulation
- External reference

Shunt regulator



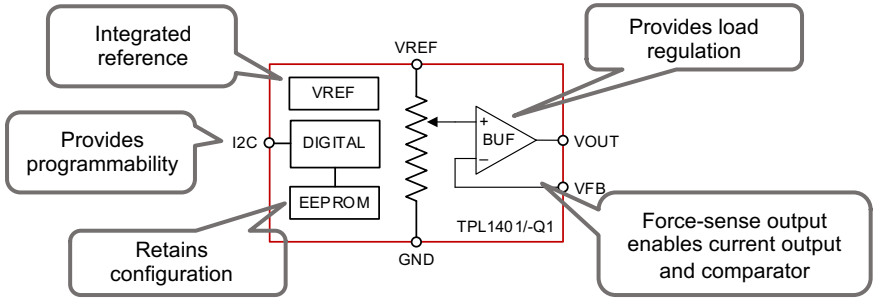
- No programmability
- No load regulation

Load regulation

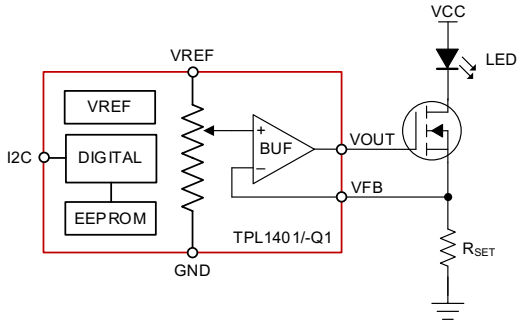


- Large area
- Limited programmability

TPL1401 differentiation

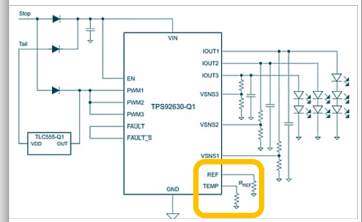


Example application

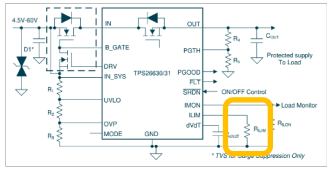


Adjustable current limit

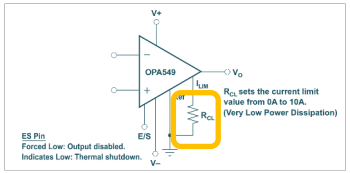
LED driver, DC-DC converter



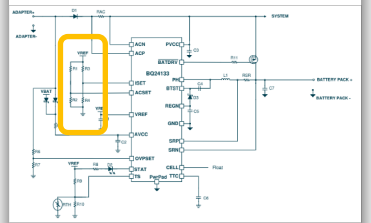
E-fuse, High-side switch



amplifierPower

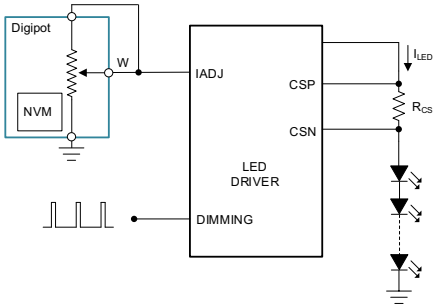


Standalone battery charger



Standard digipot

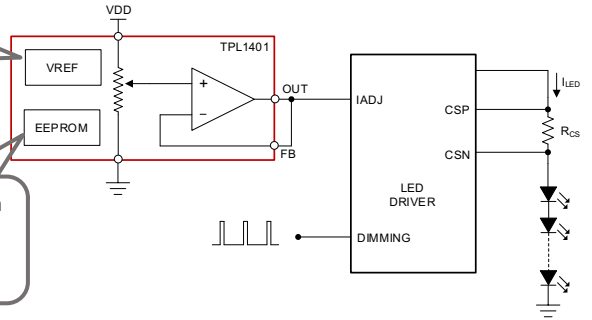
- Digipots are commonly available in 20% tolerance
- Higher accuracy digipots are expensive



TPL1401 differentiation

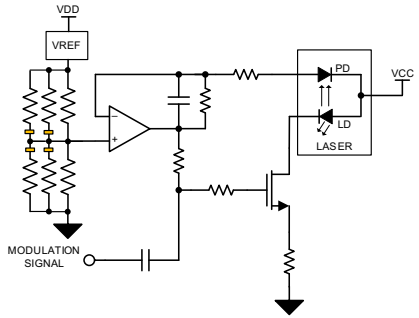
Integrated reference provides 1% accuracy

EEPROM with > 40 years usable life at 125 °C



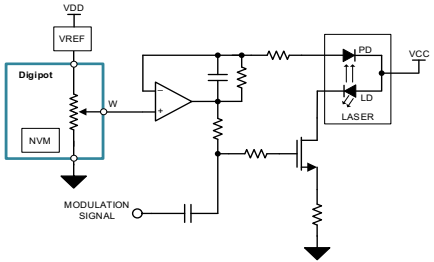
LASER diode analog power control (APC)

Resistor divider



- External reference
- Limited programming steps
- Larger area

Standard digipot

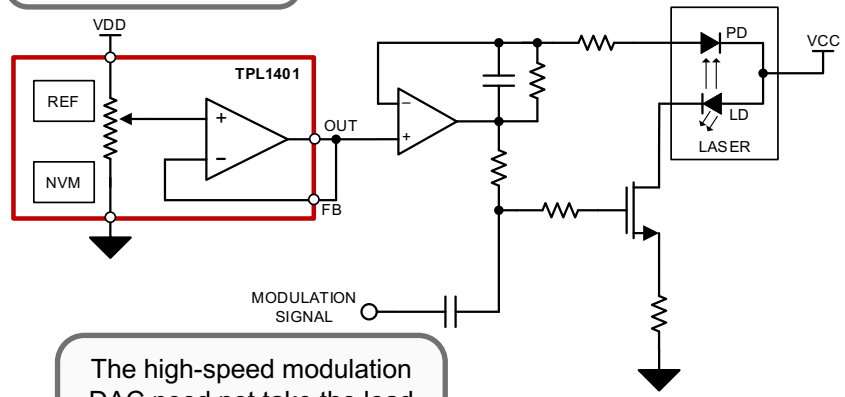


- External reference
- Digital programmability
- Larger area

TPL1401 differentiation

Program at factory and eliminate run-time programming

Simple way to set an accurate bias point for the LASER



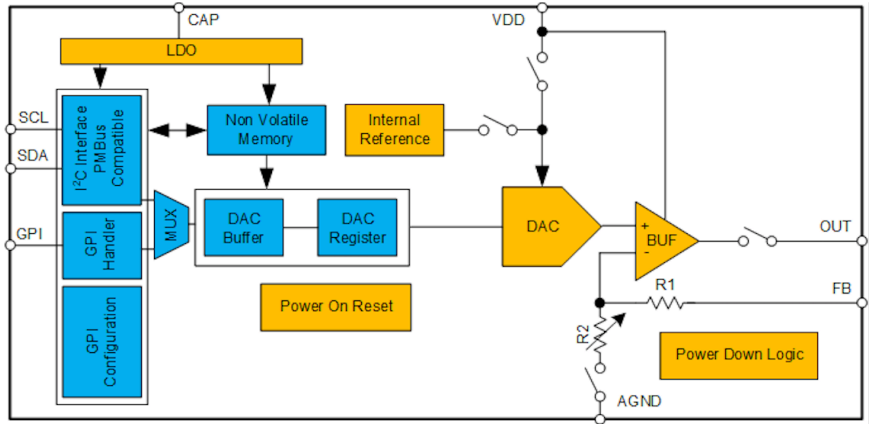
The high-speed modulation DAC need not take the load of controlling the biasing dynamically

An example Smart DAC

- GPIO configurable as power-down, PWM input, function trigger, or fade-in fade-out trigger
- User programmable Nonvolatile memory
- PWM output using free-running triangular waveform and FB pin
- I2C interface

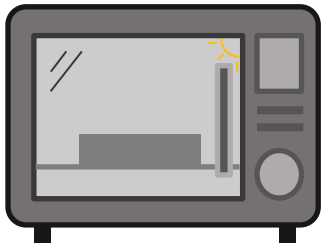
- Wide Temperature range: -40°C to +125°C
- Small package WQFN-8 (2x2)

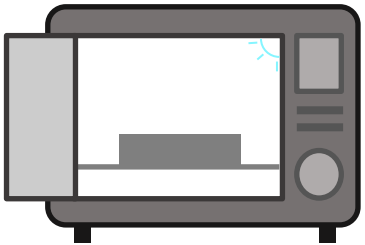
DAC53701-Q1

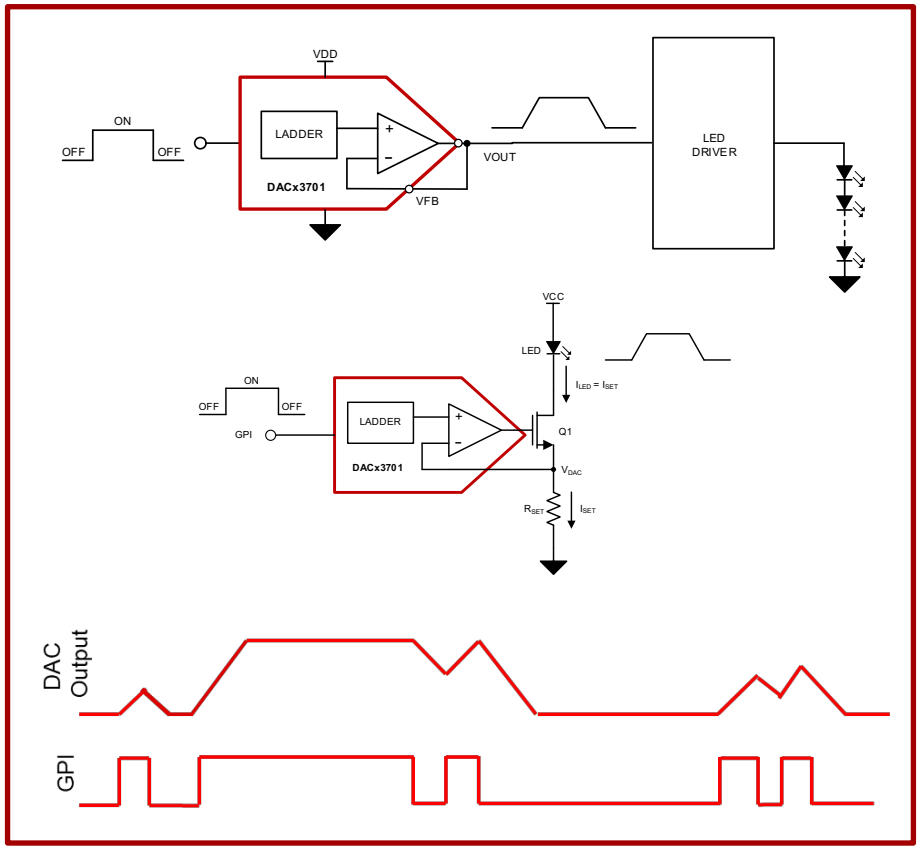


Appliance light fade-in fade-out

- GPI based fade-in fade-out
- Programmable slew rates from milliseconds to 5 seconds
- Programmable min and max output levels
- GPI can be directly connected to mechanical switch without MCU/software
- DAC can drive either an LED driver or directly drive LEDs using a MOSFET





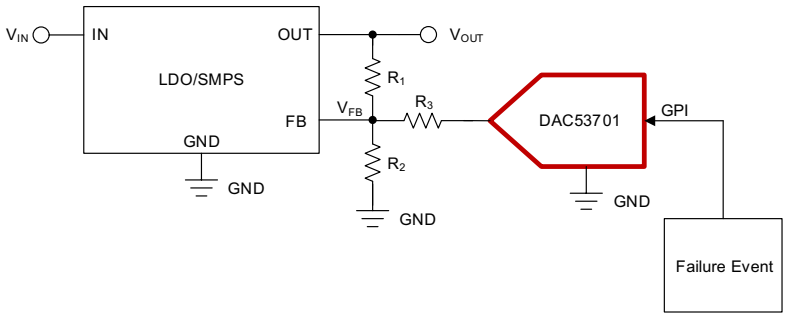


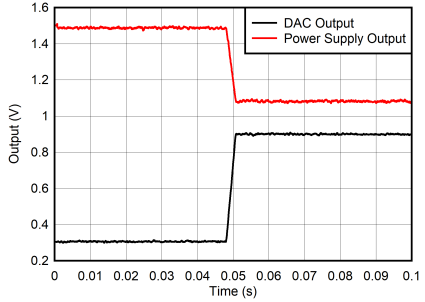
Voltage margining and scaling

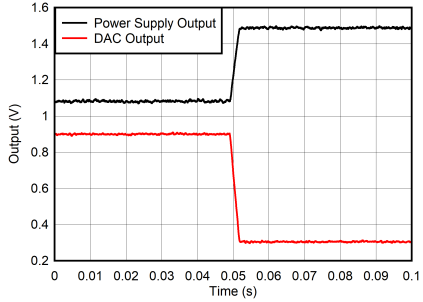
- Hi-Z power-down by default
- Digital slew rate control for glitch-free voltage scaling
- GPI to take the output to Hi-Z or other safe level when software crashes or during brown-out
- I2C and PMBus compatible interface
- NVM for predictable power-up

$$I_{MARGIN} = \left(\frac{V_{OUT} \times (1 + MARGIN) - V_{FB}}{R_1} \right) - I_{NOMINAL}$$

$$R_3 = \frac{|V_{DAC} - V_{FB}|}{I_{MARGIN}}$$

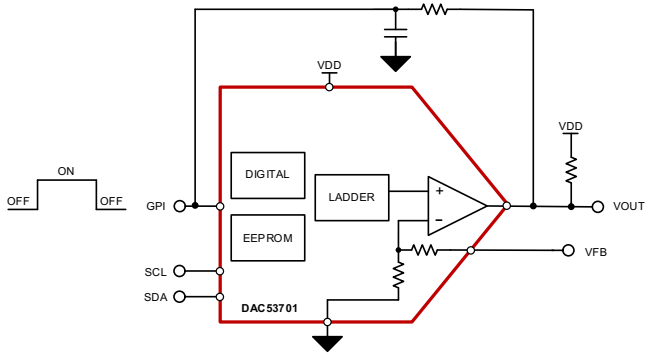




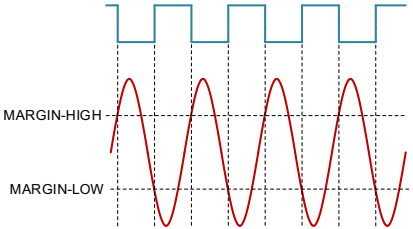


Programmable comparator

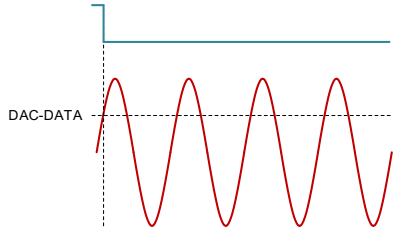
- Programmable hysteresis and latching functions independent of MCU
- 10-bit comparator threshold
- 10-bit hysteresis programmed using margin-high and margin-low registers
- Latching comparator function
- EEPROM retention > 40 years at 125 °C operating temperature, suitable for industrial applications



Programmable hysteresis
(GPI mapped to margin-high/low)



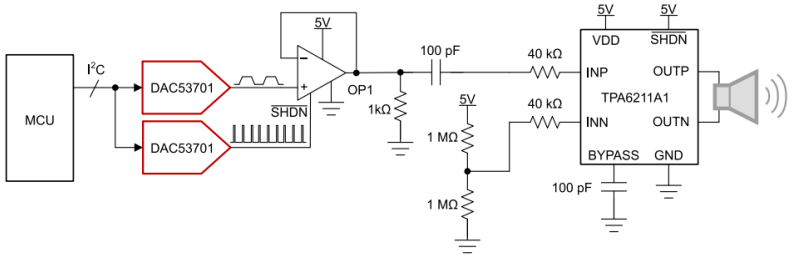
Latching comparator
(GPI mapped to power-up/down)



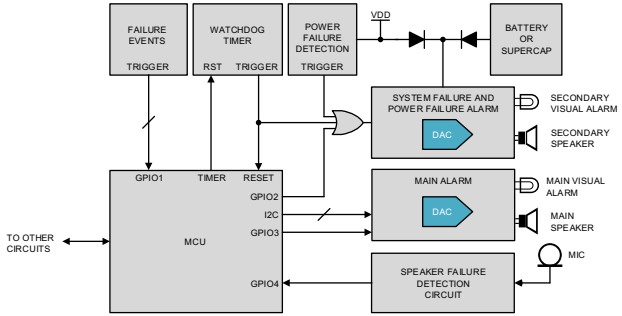
Programmable comparator	Programmable hysteresis	Latching comparator
• Comparator threshold is programmed in DAC-DATA register • GPI is unmapped	• GPI mapped to margin-high (GPI HIGH) and margin-low (GPI LOW) • DAC-DATA is same as either margin-high or margin-low • DAC output is pulled up by a resistor to VDD	• GPI mapped to power-up (GPI HIGH) and power-down to 10K (GPI LOW) • DAC-DATA is the comparator threshold • DAC output is pulled up by a resistor to VDD

Medical alarm using DAC53701

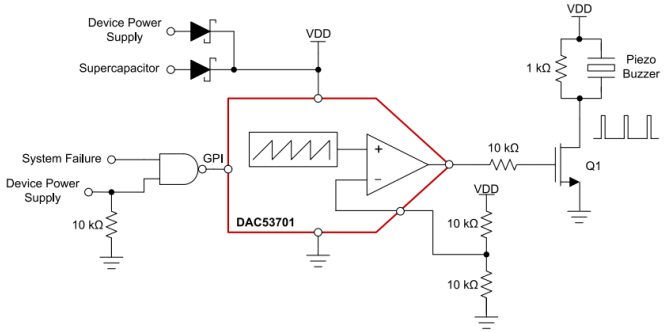
Say Goodbye to software criticality by offloading medical alarm to a programmable HW solution using Smart DACs



Secondary alarm that triggers from a WDT when software crashes or during a single-fault condition



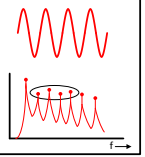
Low-power operation to run from a supercapacitor when power fails



Pre-configured alarm patterns with programmable timings

Pulse

- Pulse frequency shall be between 150 Hz and 1 kHz
- There shall be 4 harmonics between 300 Hz and 4 kHz
- These 4 harmonics shall be within ±15 dB of each other
- The harmonics shall be measured in the acoustic domain

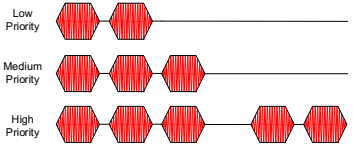


Pulse Envelope

- Specifies the rise and fall times (7.5 ms to 100 ms)
- Measured in the acoustic domain
- This signal block repeats within an alarm burst

Burst

- The pattern of the burst varies based on the alarm priority
- There are 3 alarm priorities
- Medical equipment manufacturers choose different timings and frequency as per their preference

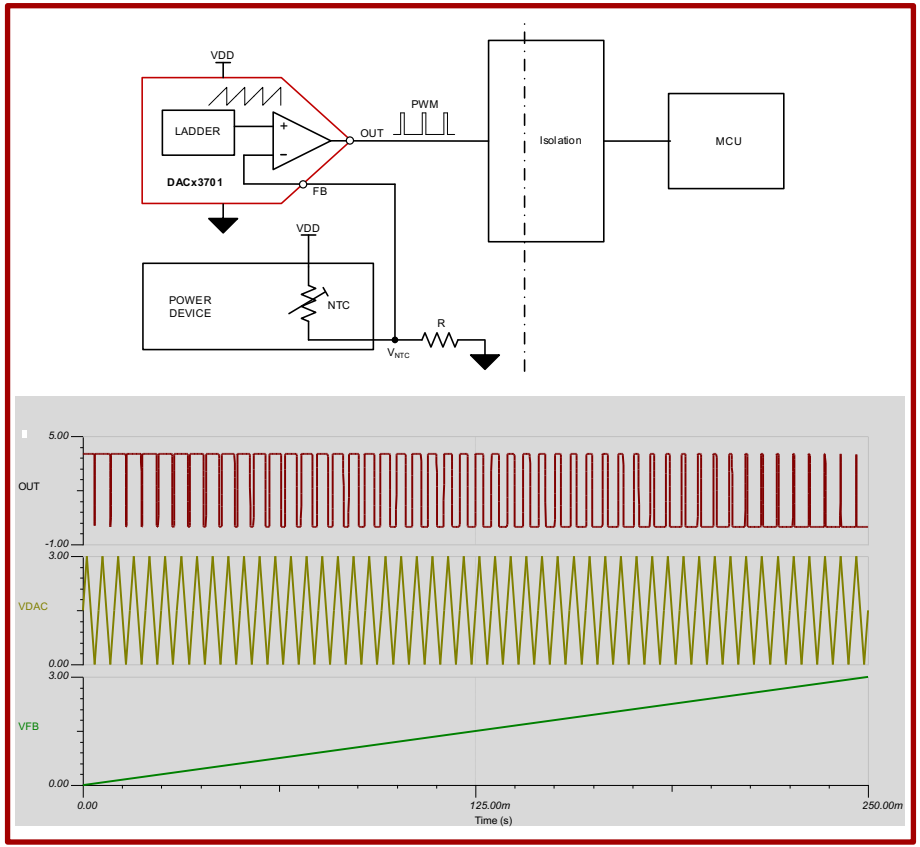


Analog to PWM converter

- NTC resistance or analog voltage to PWM conversion
- PWM interfaces needs only single-wire – suitable for isolation barriers
- PWM duty cycle proportional to NTC resistance or voltage
- Factory programming of PWM frequency through triangular / sawtooth waveform in NVM
- No run-time software required

$$f_{TRIANGLE-WAVE} = \frac{1}{2 \times SLEW\_RATE \times \left(\frac{MARGIN\_HIGH - MARGIN\_LOW + 1}{CODE\_STEP} \right)}$$

$$f_{SAWTOOTH-WAVE} = \frac{1}{SLEW\_RATE \times \left(\frac{MARGIN\_HIGH - MARGIN\_LOW + 1}{CODE\_STEP} \right)}$$

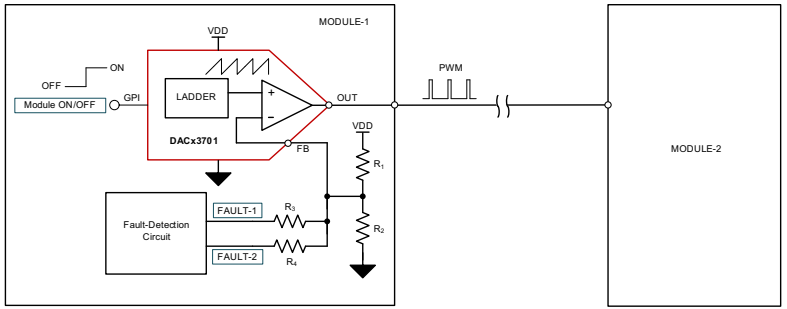


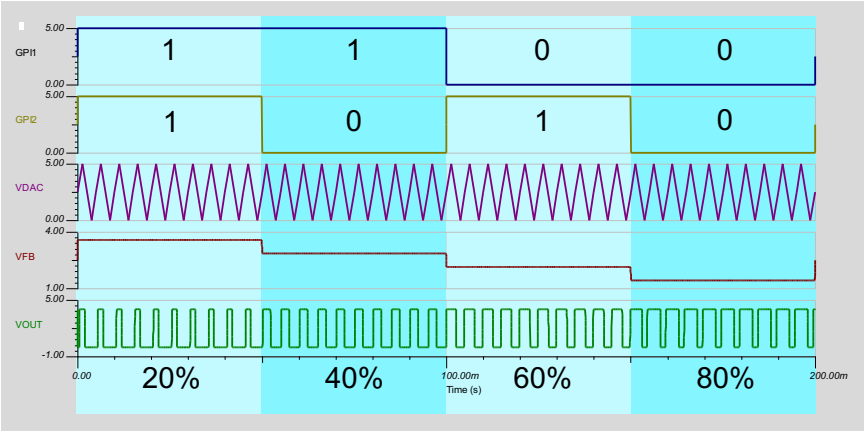
Fault communication

- Static fault signals are converted to analog signal by super-position
- 2 fault signals correspond to 4 possible PWM duty-cycles
- Software programmability of PWM frequency through triangular / sawtooth waveform
- No run-time software required

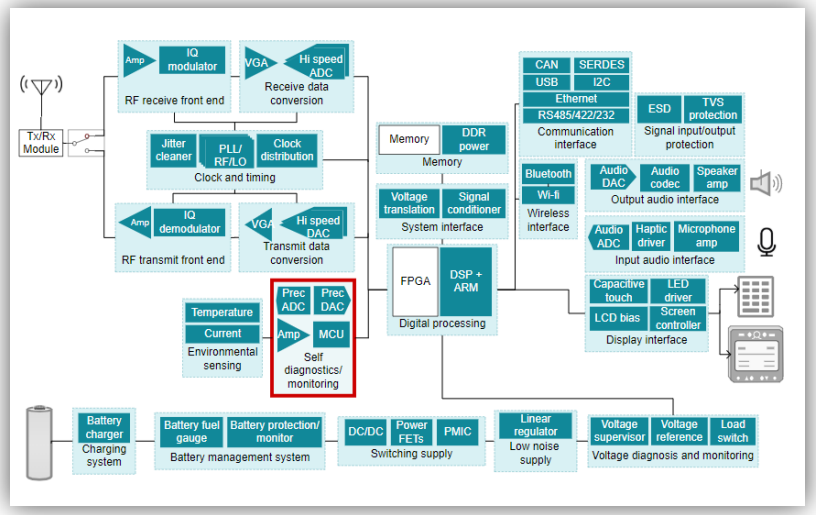
$$f_{TRIANGLE-WAVE} = \frac{1}{2 \times SLEW\_RATE \times \left(\frac{MARGIN\_HIGH - MARGIN\_LOW + 1}{CODE\_STEP} \right)}$$

$$f_{SAWTOOTH-WAVE} = \frac{1}{SLEW\_RATE \times \left(\frac{MARGIN\_HIGH - MARGIN\_LOW + 1}{CODE\_STEP} \right)}$$



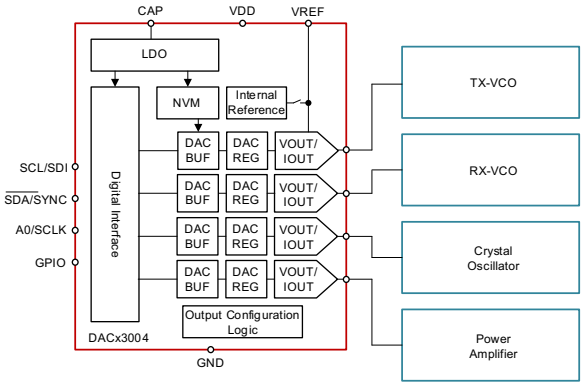


DAC63004: Ultra-low Power 12/10-bit DAC



Key Requirements:
1. 4-channel
2. 10-bit or 12-bit
3. Low-power

DAC63004



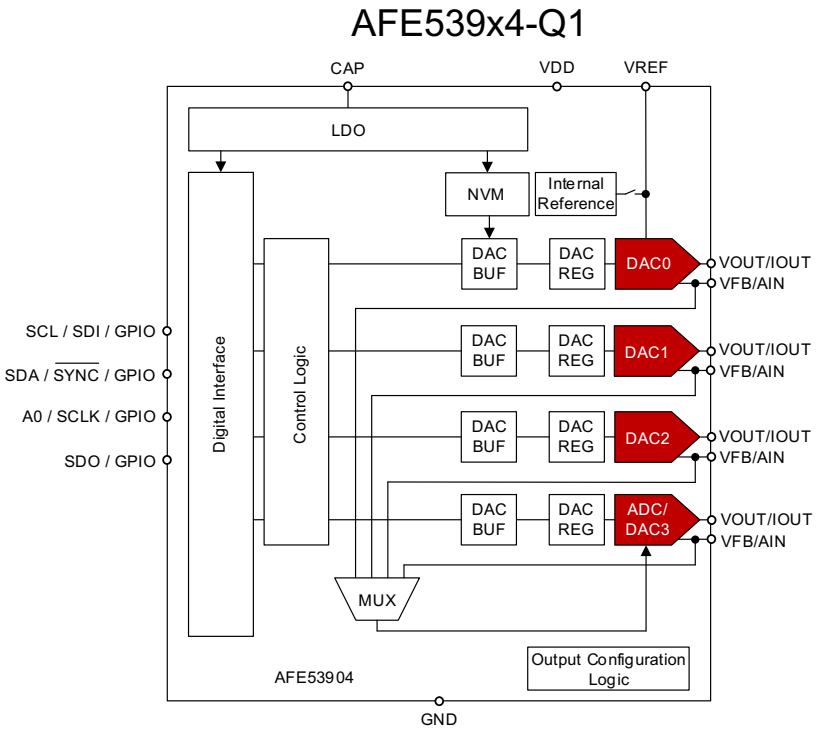
Key Spec
- Ultra-low power: 50 uA/ch
- 12-bit dual/quad channels
- Small size

Applications
- Land mobile radio, Battery operated test equipment and medical devices

An example Smart analog frond end (AFE)

- User programmable Nonvolatile Memory (NVM/EEPROM)
- I2C and SPI mode auto-detection
- GPIO interface
- PWM output
- Hi-Z output during power-off condition
- 10-bit ADC mode for all channels
- Control logic that supports look-up table and closed-loop control

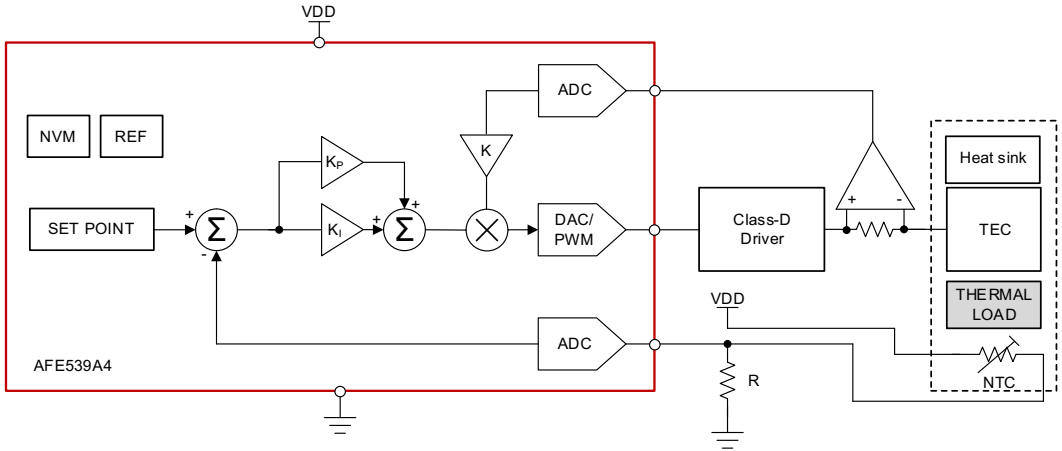
- Wide Temperature range: -40°C to +125°C
- Small package WQFN-16 (3x3)



Thermoelectric cooling (TEC) control

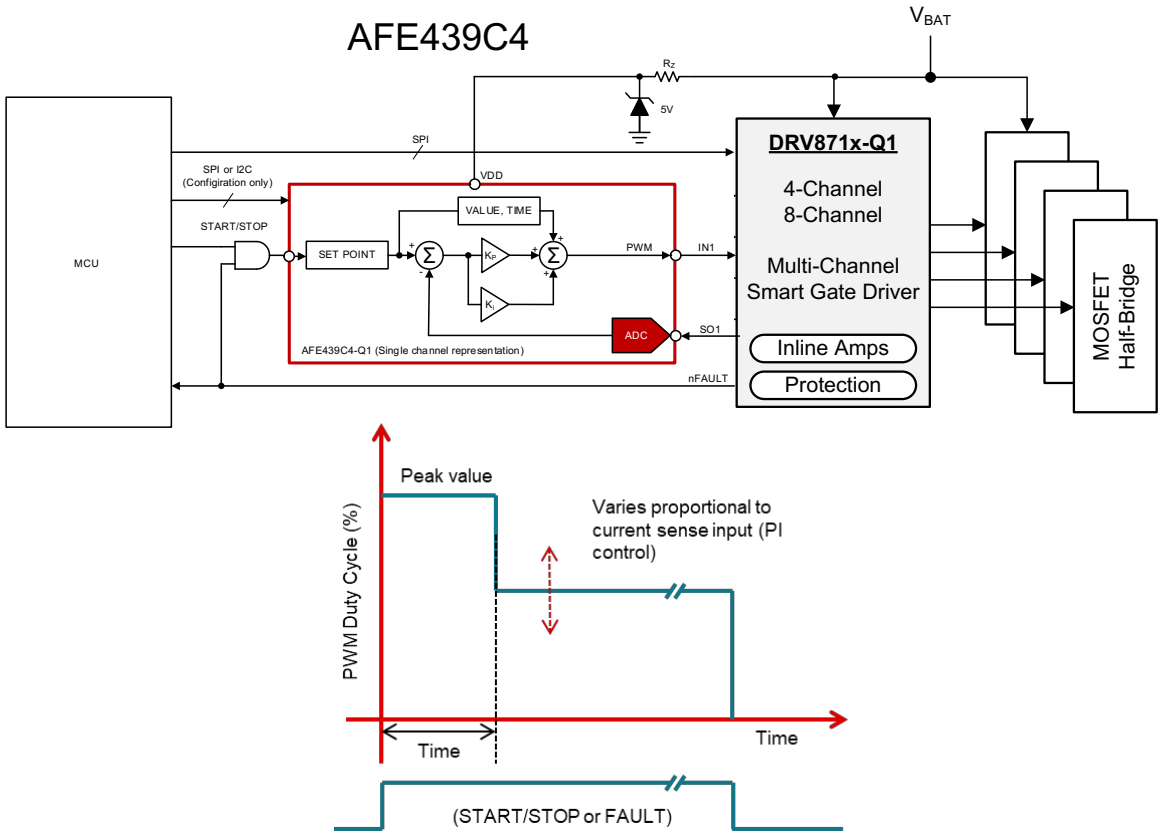
- Integrated DAC and ADC for closed-loop PI control w/o MCU
- PWM output to control external H-bridge
- Direct NTC interface to ADC
- TEC current sensing and compensation
- I2C/SPI interface for NVM programming at production
- Integrated reference and NVM
- No run-time software required

AFE539A4

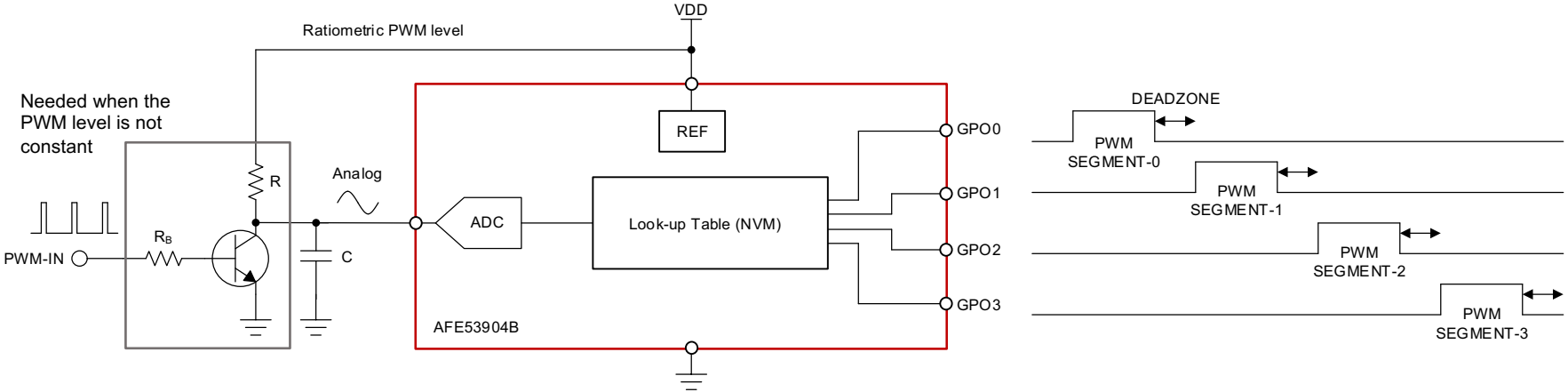


Solenoid valve control

- Programmable Peak-and-Hold control (2 independent loops)
- Integrated DAC and ADC for closed-loop PI control w/o MCU
- PWM output to control DRV871x
- Current sense from DRV871x to ADC
- GPIO based START/STOP command from MCU
- I2C/SPI interface for NVM programming at production
- Integrated reference and NVM
- No run-time software required



AFE439B4-Q1 PWM IO Expander



ADC0 Segment	ADC0 Range	GPO0 (1-bit)	GPO1 (1-bit)	GPO2 (1-bit)	GPO3 (1-bit)
SEGMENT0 (16-bit)	VALUE0 (8-bit) –> VALUE1 (8-bit)	HIGH/LOW	HIGH/LOW	HIGH/LOW	HIGH/LOW
SEGMENT1 (16-bit)	VALUE2 (8-bit) –> VALUE3 (8-bit)	HIGH/LOW	HIGH/LOW	HIGH/LOW	HIGH/LOW
SEGMENT2 (16-bit)	VALUE4 (8-bit) –> VALUE5 (8-bit)	HIGH/LOW	HIGH/LOW	HIGH/LOW	HIGH/LOW
SEGMENT3 (16-bit)	VALUE6 (8-bit) –> VALUE7 (8-bit)	HIGH/LOW	HIGH/LOW	HIGH/LOW	HIGH/LOW
DEADZONE	VALUE1 -> VALUE2, VALUE3 –> VALUE4, VALUE5 –> VALUE6, VALUE7 –> 100%	RETAIN/LOW	RETAIN/LOW	RETAIN/LOW	RETAIN/LOW
OFF-STATE	0% –> VALUE0	HIGH/LOW	HIGH/LOW	HIGH/LOW	HIGH/LOW

Smart DACs on TI.com. Smart AFEs out soon..

Smart DACs

Increase control functions using smart digital-to-analog converters (DACs). Smart DACs are DACs or digipots with output buffer and nonvolatile memory capabilities. The advanced integrated features in smart DACs enable greater system performance and control without the use of software.

View featured smart DACs >

Uttama Kumar Sahu: uttama@ti.com

Gavin Bakshi: g-bakshi@ti.com

Abhi Muppiri: abhishekmuppiri@ti.com

Smart DAC: TPL1401 / TPL1401-Q1

RELEASED!

256-tap High Accuracy DPOT with Buffered Wiper

Features

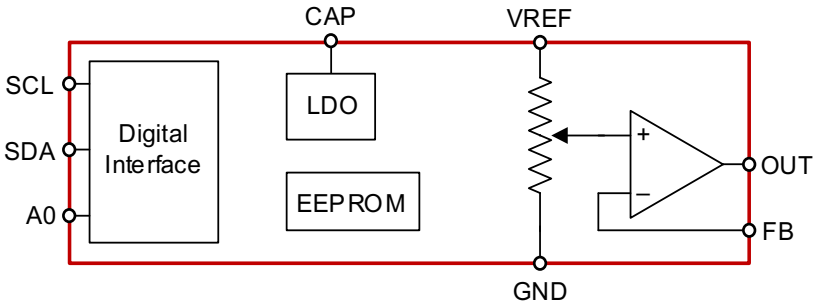
- 256-Position single channel
- 1% total accuracy
- **Buffered wiper for improved load regulation**
- FB pin for precision current sink applications
- **User programmable Nonvolatile memory**
- **Lock bit to protect from accidental writes to the resistor value**
- **High impedance or programmable start-up using NVM**
- I2C interface with 4 configurable addresses
- Ground terminated resistor
- Internal 1.22-V reference
- External VREF: 1.8V to 5.5V
- 1.8V IO voltage support
- Temperature range: -40°C to +125°C

Applications

- Precision Setpoint Thresholds
- LASER diode analog power control (APC)
- Adjustable Power Supplies
- Adjustable Gain Amplifiers and Offset Trimming
- Sensor Trimming and Calibration
- Precision Current Sink

Benefits

- Compact and low cost
- High initial accuracy
- Buffered wiper isolates the resistor string from the load impedance, ensuring high load regulation
- Replacement for non-programmable precision resistors
- Ability to tweak with I2C interface

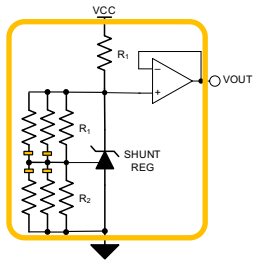


Similar Products TPL0401, TPL0501, TPL0102

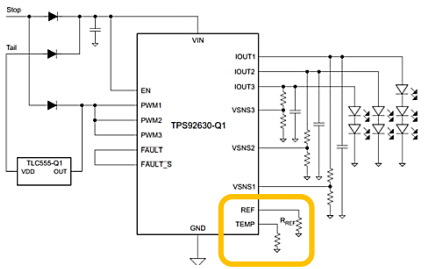
TPL1401 application summary

- Losing yield at factory? Does the voltage need tuning at factory or at the field?
  - Does the PCB need HW change for every new revision?
  - Are you struggling to find the right way to generate a DC set-point?

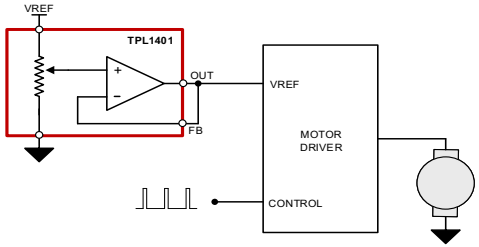
Voltage divider, Adjustable shunt regulator



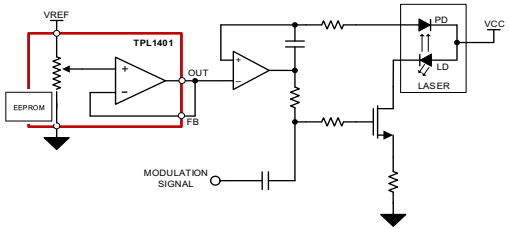
Adjustable current limit



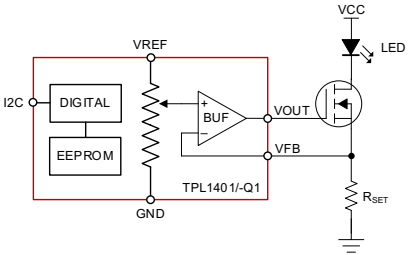
Adjustable reference



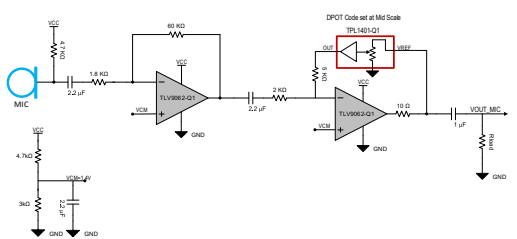
LASER diode



LEDs



Microphone tuning



TPL1401 guide to Find More Win More

Find	Around these components or in these EEs	Ask following question	Win with TPL1401 because
Voltage divider or Adjustable shunt regulator	1. Signal limit comparators 2. Over-current protection (OCP) 3. Over-voltage protection (OVP) 4. Window comparators	1. Does the voltage divider need a reference source? 2. Is the voltage divider / shunt regulator connected to an unbuffered load? 3. How fast does the comparator need to be?	1. TPL1401 has integrated reference and buffer for accuracy and load regulation. 2. TPL1401 can do factory line trim to avoid yield loss and improve quality 3. TPL1401 can be used as a programmable comparator with < 100us response time
Adjustable current limit	1. Power amplifier 2. E-fuse 3. High-side switches 4. DC-DC converters 5. LED drivers 6. Battery chargers	1. Are you using a resistor to ground or supply for the current limit? 2. Would you prefer the current limit to be adjustable?	1. TPL1401 is programmable through I2C 2. TPL1401 has an integrated EEPROM for predictable power up
Adjustable reference	1. DC motor drivers 2. ADCs 3. Bridge circuits	1. Does the motor driver need micro-stepping or torque control? 2. Does the ADC reference need to be adjustable? 3. Does the bridge circuit need linearization?	1. TPL1401 has integrated reference and buffer for accuracy and load regulation 2. TPL1401 is programmable through I2C 3. TPL1401 has an integrated EEPROM for predictable power up
LASER diodes	1. Vacuum cleaners, power tools with distance measurement 2. Barcode scanners 3. Barcode readers 4. LASER scanners 5. LASER markers	1. Does the system implement analog power control loop (APC) for the LASER diode? 2. Is the EE cost and area sensitive?	1. TPL1401 has integrated reference and buffer for accuracy and load regulation 2. TPL1401 is programmable through I2C 3. TPL1401 has an integrated EEPROM for predictable power up 4. TPL1401 is low-cost and small size
LEDs	1. USB chargers 2. Pulse oximeters, IVD devices	1. Does the LEDs need trimming at factory? 2. Does the LED need accurate control?	1. TPL1401 has integrated reference and buffer for accuracy and load regulation. 2. TPL1401 can do factory line trim to avoid yield loss and improve quality 3. TPL1401 is low-cost and small size
Microphone	1. Microphone capsule 2. Microphone arrays	1. Does the microphone needs sensitivity tuning at factory? 2. Does the microphone array need matching sensitivity among the microphones?	1. TPL1401 can be used as a programmable gain / attenuation device for audio applications 2. TPL1401 can do factory line trim to avoid yield loss and improve quality 3. TPL1401 is low-cost and small size

Smart DAC: DAC53701 / DAC43701/-Q1

RELEASED!

10/8 bit Single Channel DAC with GPIO Trigger for Automotive and Industrial Applications

Features

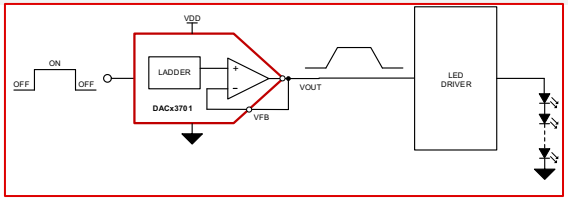
- **GPIO configurable as power-down, PWM input, function trigger, or fade-in fade-out trigger**
- **User programmable Nonvolatile memory**
- **PWM output using free-running triangular waveform and VFB pin**
- I2C interface
- Voltage output with flexible configuration
  - 1 LSB INL and DNL, Gain of 1.5, 2, and 3
- Wide operating range
  - Power supply: 1.8 V to 5.5 V
  - Temperature range: -40°C to +125°C
- Internal 1.22-V reference
- Small packages
  - WQFN-8 (2x2)

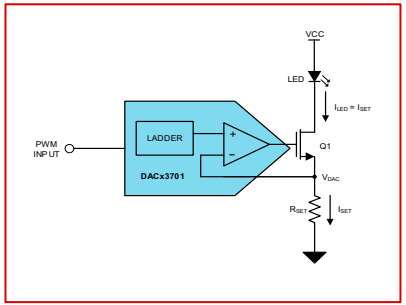
End-equipment

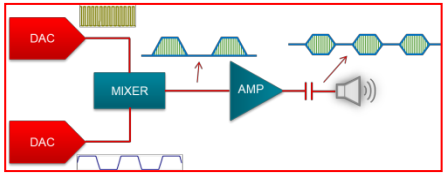
- Appliance door light fade-in fade-out
- Medical alarm
- Automotive license plate / reading lamp fade-in fade-out
- Automotive PWM based dimming for LED indicators
- Automotive STP/Tail lighting

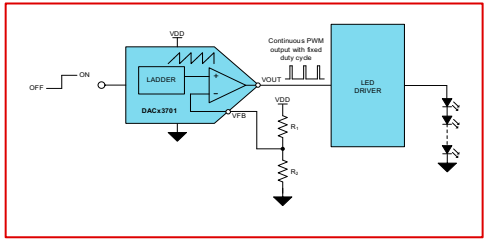
Benefits

- Building block for Programmability without SW
- Configurable GPIO input to play waveform for fade-in fade-out
- Accurate LED current setting





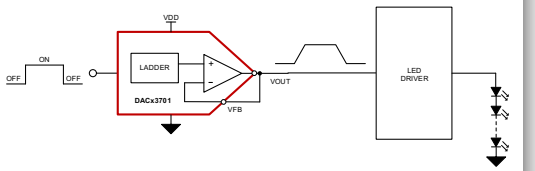




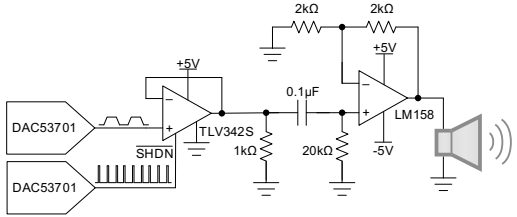
DAC53701 application summary

- Are you using an MCU just to create an adjustable PWM? Are you stuck with a 555 timer?
- Are you avoiding simple fade-in fade-out effects in lighting because of cost?
- Do you often notice fault management designs to be tricky?

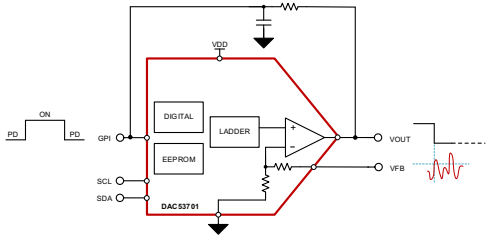
Fade-in fade-out



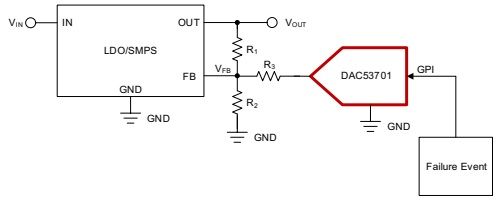
Medical alarm



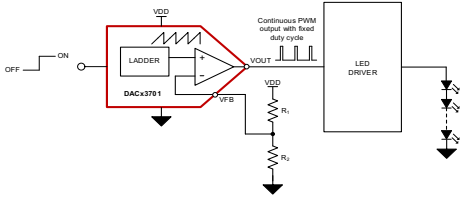
Programmable comparator



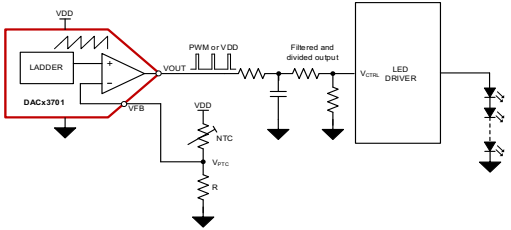
Voltage margining and scaling



PWM output



Temperature/Resistance to PWM



DAC53701 guide to Find More Win More

Find	Around these components or in these EEs	Ask following question	Win with DAC53701 because
Fade-in fade-out	1. Oven, appliances 2. Car license plate 3. Reading/dome lights	1. Do you prefer smooth dimming effects for your appliance door light? 2. Are you burdened by non-trivial software maintenance and regulatory hassles? 3. Do you require human eye response correction while dimming?	1. DAC53701 provides a GPI pin for fade-in fade-out operation with configurable timing 2. It comes with an EEPROM that can be programmed during production using i2C 3. DAC53701 can generate logarithmic slew using 2 diode and an external amplifier
Medical alarm	1. Ventilators 2. Infusion pumps 3. Patient monitors 4. Hospital beds 5. Dialysis machines 6. Power/system failure alarm	1. Is your application software classified under risk management as you are driving the alarm from application software? 2. Is the portability of the medical alarm circuit troubling you? 3. Are you looking for a light-weight, portable, and configurable medical alarm?	1. DAC53701 has integrated medical alarm function 2. The medical alarm can be triggered using the GPI. This is useful when the MCU or software fails 3. DAC53701 takes only 200uA. It can easily work from battery or a supercap during power failure 4. DAC53701 can also drive the visual alarm in synchronization with the auditory alarm
Programmable comparator	1. LASER diode circuits 2. Fuse failure detection (Grid infra) 3. Programmable hysteresis 4. Latching comparator	1. Do you need fault management in your system? 2. Do you prefer less MCU involvement in the fault management?	1. DAC53701 can be used as a programmable comparator for ~100us response time 2. DAC53701 provides 10-bit programmable hysteresis 3. It can work as a latching comparator 4. In the PWM mode, DAC53701 can also transmit the status of the comparator to a long distance
Voltage margining and scaling	1. DC-DC voltage margining and scaling 2. Margin-high/low testing 3. Enterprise servers 4. Datacom modules 5. Fail safe mode	1. Does your ASIC/CPU need accurate voltage scaling? 2. Do you want to have a fail safe mode without using an MCU?	1. DC53701 has Hi-Z power-down mode 2. It has slew rate control 3. It provides PMBus compatible I2C interface 4. The GPI pin can be used as a fail safe input trigger 5. The GPI pin can also be used as a margin-high/low toggle input
PWM output	1. STOP tail lighting control 2. PWM expansion 3. System status transmitter 4. 555 timer replacement	1. Do you need matching intensity between the trunk and fender lights without additional harness? 2. Do you need to translate the duty cycle of the master PWM for individual loads? Are you using an MCU for this? 3. Do you need to transmit the status of a system in a robust but simple way? 4. Do you need a simple way to generate a PWM signal?	1. DAC53701 can generate tunable PWM output to drive LED drivers 2. The PWM can be triggered from the GPI 3. DAC53701 can translate the duty cycle of an incoming PWM signal and generate a new PWM signal with the translation factor stored in the EEPROM
Resistance to PWM	1. Resistance to PWM conversion 2. Temperature to PWM conversion 3. LED thermal foldback 4. Thermal switch for IGBT modules with integrated thermistor	1. Are you using an ADC or an MCU to convert a resistance or temperature to digital? 2. How do you transmit an NTC value across isolation barrier? 3. Are you using complex discrete circuit for thermal foldback of daytime running light (DRL)? 4. How do you achieve thermal protection of IGBTs and indicate it to a processor? Are you using costly ADCs for this?	1. DAC53701 can take a resistance or NTC input and generate a PWM output 2. It can achieve single-slope thermal foldback for DRL lighting without an MCU 3. DAC53701 can act as a thermal switch in the programmable comparator mode without an MCU

Smart DAC: DAC53204

SAMPLE NOW!

10 bit Quad DAC for Power Supply Margining and Adaptive Voltage Scaling (AVS)

Features

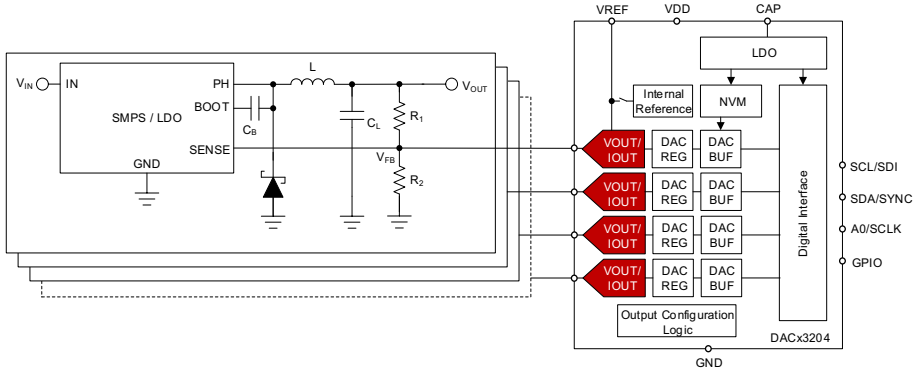
- Hi-Z output at power-off and during power-up
- PMBus compatible I2C interface
- Power rail brownout protection using PROTECT pin
- Programmable slew rate control
- TOGGLE input for MCU-less margining
- Low power operation
- I2C and SPI mode auto-detection
- Voltage output with flexible configuration
  - 1 LSB INL and DNL, Gain of 1, 1.5, 2, 3 and 4
- Current output
  - 1 LSB DNL (10-bit and 8-bit), 1 LSB INL (8-bit)
  - Configurable output ranges
    - 0 µA to 25 µA, ±25 µA, ±125 µA, ±250 µA
- Programmable output code limit
- Wide operating range
  - Power supply: 1.8 V to 5.5 V
  - Temperature range: -40°C to +125°C
- Internal 1.22-V reference
- User programmable Nonvolatile memory
- Small packages
  - WQFN-16 (3x3)

End-equipment

- Optical line cards and optical modules
- Rack server, Ethernet switches and routers
- PC and Notebooks, Tablet

Benefits

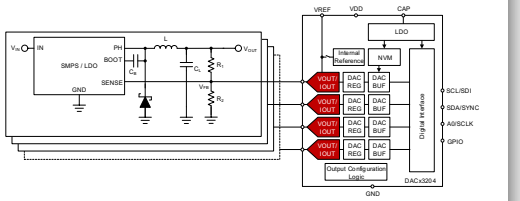
- Eliminates external power-supply sequencing
- Enhances robustness with configurable PROTECT (GPIO) pin
- Suitable for battery-operated applications
- Seamless integration into AVS applications



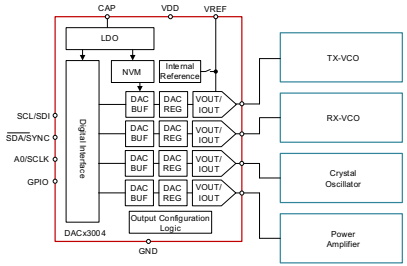
DAC53204 application summary

- Does your system require accurate bias points?
- Does your voltage margining circuit require a DAC that has Hi-Z output even during power-off?
- Do you often notice fault management designs to be tricky?

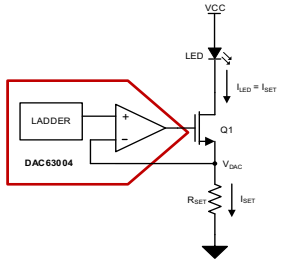
Voltage margining and scaling



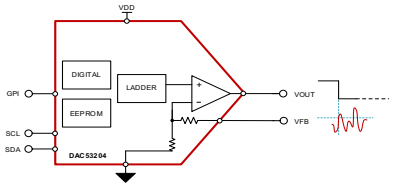
Amplifier and VCO biasing



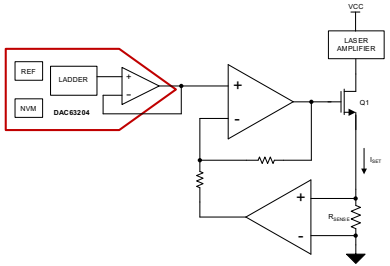
Ultra-low power LED biasing



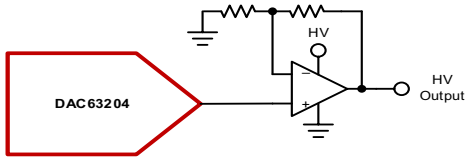
Programmable Comparator



LASER amplifier control



MEMS LIDAR scanning



Smart AFE: AFE539x4

SAMPLE NOW!

10 bit Quad Smart AFE – A new building block

Features

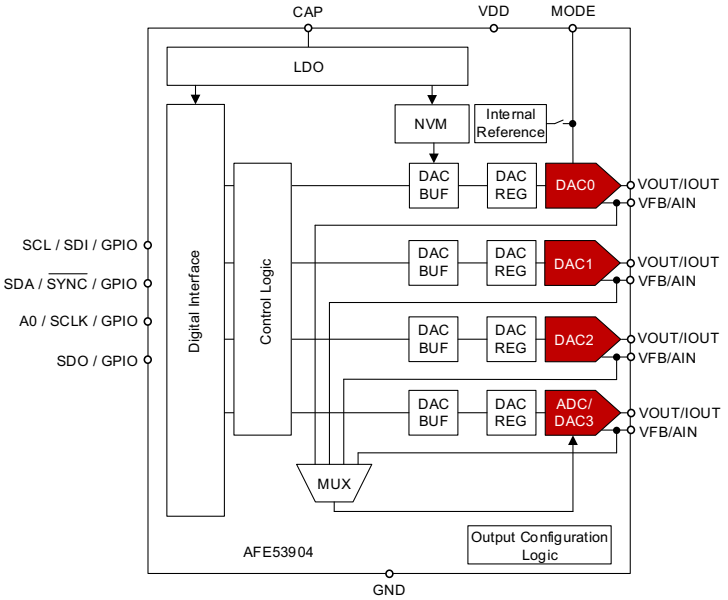
- **User programmable Nonvolatile Memory (NVM/EEPROM)**
- **I2C and SPI mode auto-detection**
- Internal 1.22-V reference
- **Hi-Z output during power-off condition**
- **GPIO pin configurable as LDAC/PRESET/SDO/PDN/ALARM**
- **10-bit ADC mode for all channels**
- **Control logic that supports feed-forward and closed-loop control**
- Voltage output with flexible configuration
  - 1 LSB INL and DNL, Gain of 1, 1.5, 2, 3 and 4
- Current output
  - 1 LSB INL (8-bit), 1 LSB DNL
  - Configurable output ranges
    - 0 µA to 25 µA, ±25 µA, ±125 µA, ±250 µA
- Wide operating range
  - **Power supply: 1.8 V to 5.5 V**
  - Temperature range: -40°C to +125°C
- Small packages
  - WQFN-16 (3x3)

End-equipment

- Ethernet switches and routers
- Handheld medical devices, test & measurement equipment
- Automotive lighting
- Land mobile radio

Benefits

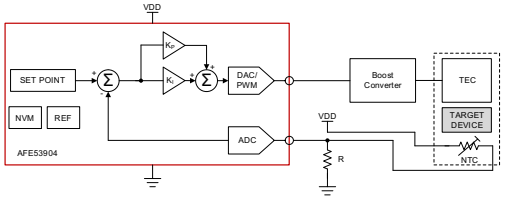
- High design-reuse with multiple digital interface and analog output options
- Set-and-forget mode operation off-loads housekeeping MCU/EC
- Autonomous mode provides logic to analog circuits without software
- Ultra-low power enables longer run-time for battery-operated applications



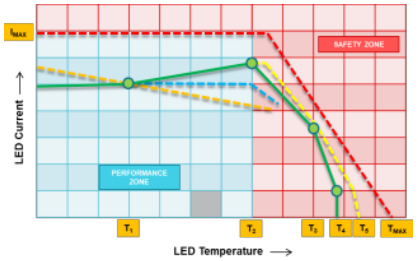
AFE539x4 application summary

- Are you using an MCU to create simple control loops?
- Does your system have shortage of GPIOs or have the need for long-distance control over GPIOs?
- Are you burdened by software to create LED animations?

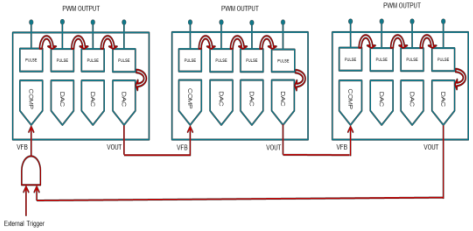
TEC control, PI control



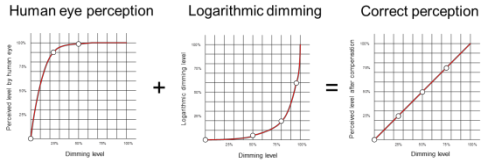
Multi-slope thermal foldback



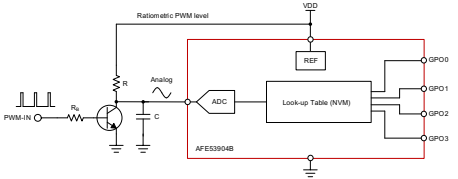
LED animation



Logarithmic fade-in fade-out



PWM IO expander



Dynamic headroom control