

MAX86176/MAX30005

Ultra-Low-Power, Optical PPG and Single-Lead ECG AFE

General Description

The MAX86176 is a complete photoplethysmogram (PPG) and electrocardiogram (ECG) analog front-end (AFE) solution for wearable applications. The MAX30005 is a complete AFE solution for ECG only. Both AFEs offer high performance for fitness and clinical applications with ultra-low power for long battery life.

Both MAX86176 and MAX30005 feature an ECG channel, EMI filtering, internal-lead biasing, AC and DC lead-off detection, right-leg drive, ultra-low power DC lead-on detection during standby mode, and extensive calibration voltages for built-in self-test. In addition, the MAX86176 has a PPG data acquisition system supporting up to 6 LEDs and 4 photodiode inputs, which is fully synchronized with the ECG signal path. The MAX86176/MAX30005 can operate with either internal or external clock. The MAX86176/MAX30005 are designed to meet IEC 60601-2-47 Ambulatory ECG Systems monitoring compliance for even the most challenging dry electrode applications.

The MAX86176/MAX30005 are available in a 6x6 36-bump wafer-level packages (WLP), operating over the -40°C to +85°C temperature range.

Applications

PPG (MAX86176)

- Wearable Devices for Fitness, Wellness and Medical Applications with Clinical Accuracy
- Suitable for Wrist, Finger, Ear and Other Locations
- Optimized Performance to Detect Heart Rate, Oxygen Saturation (SpO₂), Muscle and Tissue Oxygen Saturation (SmO₂ and StO₂), and Body Hydration

ECG (MAX86176/MAX30005)

- Single-Lead Event Monitors for Atrial Fibrillation (A-Fib) and other Arrhythmia Detection
- Single-Lead Wireless Patches for At-Home/In-Hospital Monitoring
- Chest-Band Heart-Rate Monitors for Fitness Applications
- Biometric Authentication and ECG-on-Demand Applications

PPG-ECG SYNC (MAX86176)

- Fully Synchronized PPG and ECG Signal Path for PTT Measurements

Benefits and Features

PPG (MAX86176)

- Complete Dual-Channel Optical-Data Acquisition System
- Ultra-Low-Power Operation for Wearable Devices
 - Optical Readout Channel < 11µA (typ) at 25fps
 - 14.6µs to 117.1µs ADC Integration Time
 - Low Shutdown Current < 1µA (typ)
- Signal to Noise Ratio (SNR) up to 110dB with Average (Avg) Mode and Off-Chip Filtering
- Supports Frame Rates from 1fps to 2kfps
- High-Resolution 20-bit Charge-Integrating ADCs
- Low Dark-Current Noise of < 50pA_{RMS}
- Excellent Ambient Range and Rejection Capability
 - > 100µA Ambient Photodiode Current
 - > 90dB Ambient Rejection at 120Hz (Avg > 2)

ECG (MAX86176/MAX30005)

- Clinical-Grade ECG AFE with High-Resolution ADC
 - 15.6 ENOB with 0.6µV_{RMS} Noise over 0.05Hz to 40Hz
- Very Low Input-Bias Current (-40°C to +85°C)
 - 233fA_{RMS} Input-Current Noise (0.05Hz to 40Hz, T_A = +25°C)
- Fully Differential Input Structure with CMRR > 110dB at Power-Line Frequencies
- High-Input Impedance > 1GΩ for Extremely Low Common to Differential-Mode Conversion
- High DC-Offset Range of ±1300mV (typ 1.8V) Allows a Wide Variety of Electrodes to be Used
- High AC-Dynamic Range of > 90mV_{P-P} Helps Prevent Saturation in the Presence of Motion
- ECG Biopotential Channel Can Be Used for Some EEG Applications
 - Higher-Gain Ranges Available (480V/V, 960V/V)
 - Low Input-Referred Voltage and Current Noise Enables Use of Small-Area Dry Electrodes

SYSTEM

- Shutdown Current of 0.5µA (typ)
- 256-Word FIFO for ECG and PPG
- True Synchronous ECG and PPG Data from Dedicated Signal Paths
- Two Fully Configurable Interrupts
- High-Speed SPI Interface or I²C Interface
- Small 2.728mm x 2.708mm WLP Package

[Ordering Information](#) appears at end of data sheet.

Analog Devices is in the process of updating documentation to provide culturally appropriate terminology and language. This is a process with a wide scope and will be phased in as quickly as possible.

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Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/20	Release for Market Intro	—
1	2/21	Updated the Electrical Characteristics, Pin Description, Analog Signal Chain and ADC, EMI Filtering and ESD Protection, AC Lead-Off Detection, Noise Measurements, Right Leg Drive and Body Bias, and Timing Subsystem sections; replaced TOC34; updated the RLD_EN bit description, and Typical Applications Circuit for Dry Electrode Applications, Typical Applications Circuit for Wet Electrode Applications and Typical Applications Circuit for Wet Electrode Applications; removed future product designation from MAX30005ENX+ and MAX30005ENX+T in the Ordering Information table	11–12, 15, 19, 23, 29, 40–42, 44, 46, 51, 54–56, 58, 162, 166–167, 169–170
2	2/22	Updated the Electrical Characteristics, Frame and Frame Rate, PLL and External Oscillator, Table 10, Table 11, and FIFO Description	14, 15, 17, 33, 53, 56, 66
3	7/23	Updated the Electrical Characteristics table, Frame and Frame Rate, DC Lead-Off Detection, Timing Subsystem, PLL Synchronization Mode, Configuring ECG Sample Rate and PPG Frame Rate, I ² C-/SMBus-Compatible Serial Interface, START and STOP Conditions, I ² C Target Address, Acknowledge Bit, I ² C Write Data Format, Figure 36, Figure 37, I ² C Read Data Format, Figure 38, Figure 39, Register Details, and Typical Application Circuits.	11, 38, 43, 51, 54, 57, 69–74, 83–166
4	11/24	Updated the Electrical Characteristics table, Pin Description table, Right Leg Drive and Body Bias, Timing Subsystem sections, Updated Figure 21, Table 9, Configuring ECG Sample Rate and PPG Frame Rate, PPG Timing Data sections, Register Map Details	8, 18, 27, 51, 52, 53, 54, 58, 85, 99, 147, 152