

MCP2030 Three-Channel Analog Front-End Device Overview

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INTRODUCTION

The MCP2030 is a stand-alone, Analog Front-End (AFE) device for Low-Frequency (LF) sensing and bidirectional communication applications. The device can output demodulated data, carrier clock or RSSI current. The demodulated data and carrier clock outputs are available on the LFDATA pin, while the RSSI output is available on the RSSI pin. The RSSI current output is linearly proportional to the input signal strength. Device features are controlled by the programming of its internal Configuration registers.

The device has programmable internal tuning capacitors for each input channel. The user can program these capacitors up to 63 pF, 1 pF per step. These internal tuning capacitors can be used effectively for fine-tuning of the external LC resonant circuit.

External LC resonant antenna circuits are connected to LCX, LCY and LCZ. The LCCOM pin is used as a reference terminal for each antenna connection.

The device can detect an input signal with amplitude as low as ~1 mVPP and can demodulate an amplitude-modulated input signal with as low as an 8% modulation depth. An individual channel's sensitivity can be reduced by programming the Configuration register if it is too sensitive.

The device is optimized for very low-current consumption and has various battery-saving low-power modes (Sleep, Standby, Active). The device can also be operated in Battery Backup and Batteryless modes using a few external components.

The device is available in 14-pin TSSOP, SOIC and PDIP packages. This device is also used as the AFE in the PIC16F639. Figure 1 shows the pin diagram of the device, followed by the pinout descriptions in Table 1. The key features of the device are summarized in Table 2.

FIGURE 1: PIN DIAGRAM

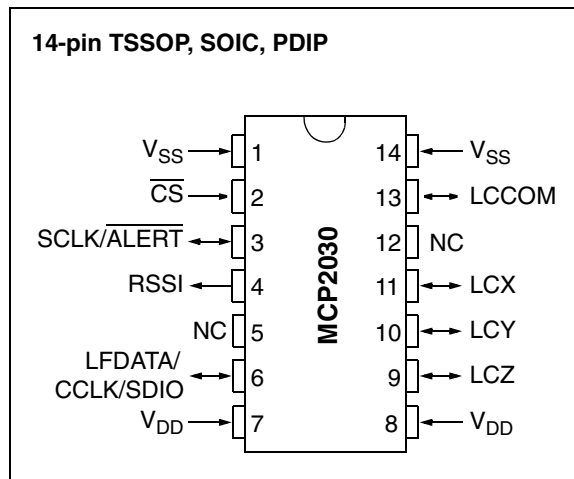


TABLE 1: PINOUT DESCRIPTION

Names	Description
V _{DD}	Supply Voltage: 1.8 - 3.6V.
$\overline{\text{CS}}$	Chip select input for the modified 3-wire SPI interface.
SCLK	Clock input for the modified 3-wire SPI interface.
$\overline{\text{ALERT}}$	Alert output. This pin goes low if there is a parity error in the Configuration register, or if the 32 ms alarm timer has timed out.
RSSI	RSSI current output.
NC	Not connected.
LFDATA	Demodulated data output.
CCLK	Carrier clock output.
SDIO	Serial input or output data for the modified 3-wire SPI interface.
LCX, LCY, LCZ	Input pins for external LC antennas.
LCCOM	Common reference input for the external LC antennas.
V _{SS}	Ground reference voltage.

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TABLE 2: DEVICE FEATURES

Parameters/Features	Description
Supply Voltage	1.8 - 3.6V
LF Input Channels: <ul style="list-style-type: none"> • Sensitivity • Input Sensitivity Reduction • Channel Selection • Modulation Depth Selection • Output Enable Pattern • LF Talk-back 	1-6 mVPP Programmable up to -30 dB (-2 dB/step) for each channel. Each channel can be individually enabled or disabled. 8%, 14%, 33%, 60% Programmable: High and low pulse durations (9 different selections). Sends data by modulating input coil voltage.
Optimum Input Frequency	125 kHz
Selectable Output Type: <ul style="list-style-type: none"> • Demodulated Data • RSSI • Carrier Clock 	Demodulated data for amplitude modulated input. Current output proportional to input signal strength. Input Carrier/1 or Input Carrier/4.
Antenna Tuning Capacitance	Programmable up to 63 pF (1 pF/step) for each channel.
Eight Configuration Registers	Readable and programmable via a modified 3-wire SPI interface. The STATUS register is read-only.
STATUS Register	Indicates channel activities, AGC active status, Alarm timer status, Parity bit error status.
Currents: <ul style="list-style-type: none"> • Sleep • Standby • Active 	200 nA (typ.) 2 μ A (1 channel enabled), 3 μ A (2 channels enabled), 4 μ A (3 channels enabled). 10 μ A (1 channel enabled), 11 μ A (2 channels enabled), 13 μ A (3 channels enabled).
Base Station Data Rate to Transponder	10 Kbps (max) with NRZ data format.
SPI commands	Read or Write Configuration registers. Commands: Clamp On, Clamp Off, Sleep, AGC Preserve On, AGC Preserve Off, Soft Reset.
Internal Soft Reset	Reset internal circuits if there is no input for 16 ms and looking for a new data packet.
32 ms Alarm timer	Set ALERT pin low and set Alarm bit high if 32 ms Alarm timer has timed out.
Operating Temperature	-40°C to +85°C

Note: This device is also used as an AFE section in the PIC16F639. Refer to the *PIC12F635/PIC16F636/639 Data Sheet (DS41232)* for more detail.

THEORY OF DEVICE OPERATION

The device detects amplitude-modulated input signals and sends data by clamping on and off the input signal. The device's features are controlled by programming the internal Configuration registers. The device has eight Configuration registers that are programmable and readable by an external microcontroller (MCU) using a modified 3-wire SPI interface. The STATUS register is a read-only register and indicates a status of the device operation in real time. The output type (demodulated data, RSSI current, carrier clock) can be selected by programming the Configuration register. When the output type is selected for the demodulated output, the device is looking for input signals with a predefined header. The valid input header structure is given in **EXAMPLE 1: "Predefined Header Format"**.

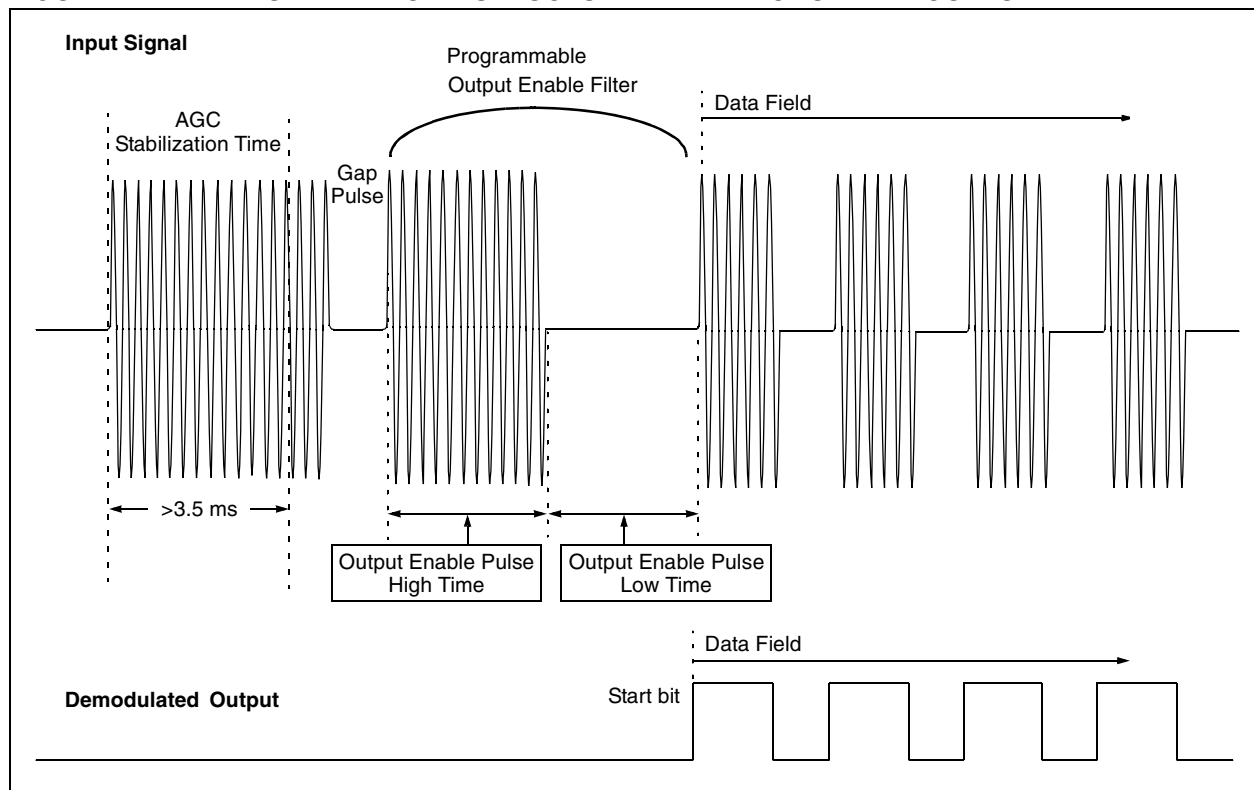
When the output enable (wake-up) filter is enabled, the demodulated output is available after the wake-up filter. Figure 2 shows a valid input waveform structure and demodulated output. The user can program the parameters of the output enable filter (or wake-up filter). The filter can also be enabled or disabled.

When the filter is enabled and the input signal meets the filter requirement, it enables the output. Otherwise, there will be no output. See more details in References [1]-[3] for the programming details of the output enable filter. The device does not require any predefined input header structure for the RSSI or carrier clock outputs.

EXAMPLE 1: PREDEFINED HEADER FORMAT

AGC Stabilization (>3.5 ms)	AGC Gap	Output Enable Filter	Data
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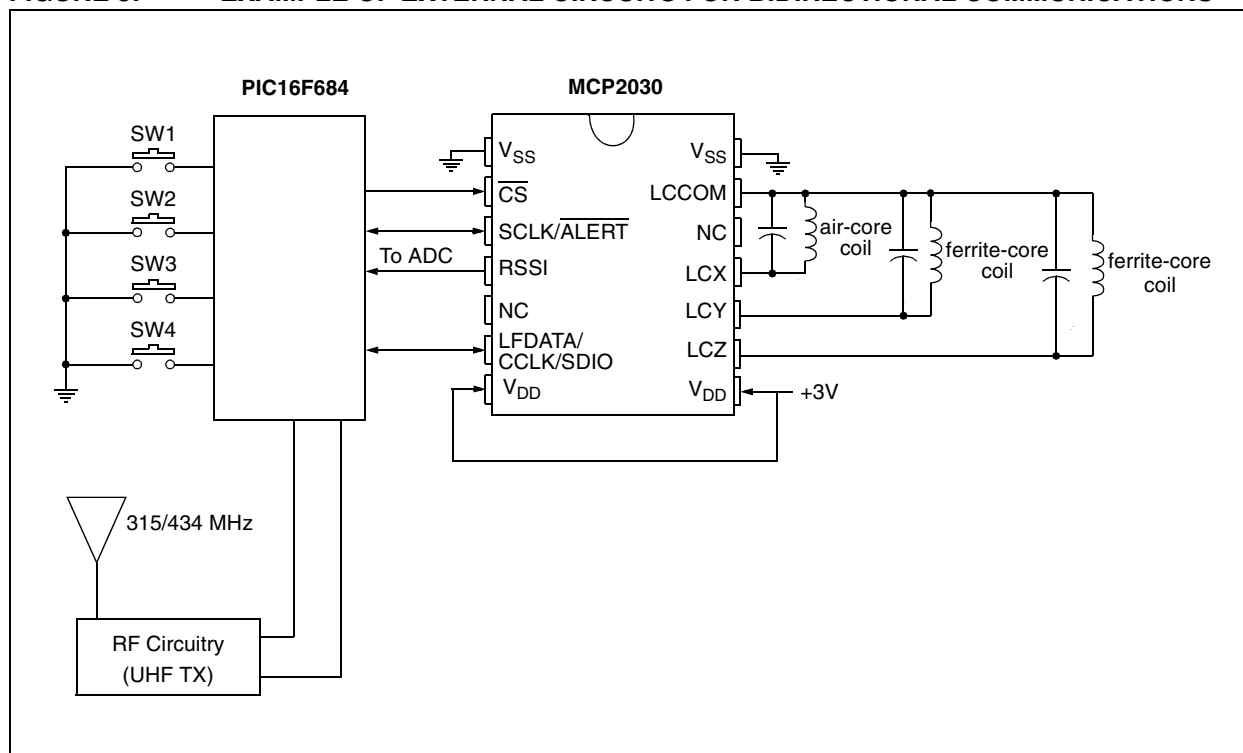
FIGURE 2: INPUT WAVEFORM STRUCTURE AND DEMODULATED OUTPUT



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Figure 3 shows an example of a bidirectional communication PKE system using the MCP2030 and PIC16F684, which has an internal Analog-to-Digital (A/D) feature. The RSSI output from the MCP2030 can be digitized by the PIC16F684 and sent to the base station.

FIGURE 3: EXAMPLE OF EXTERNAL CIRCUITS FOR BIDIRECTIONAL COMMUNICATIONS



CONCLUSIONS

The MCP2030 is a stand-alone, 3-channel AFE device for LF sensing and bidirectional transponder applications. The device's high input sensitivity (1 mVPP) and ability to detect weakly modulated input signals (8%) with low-power features make this device well suited for various applications, such as a low-cost Passive Keyless Entry (PKE) transponder, LF initiator sensor in Tire Pressure Monitoring Systems (TPMS) and long-range access control applications.

REFERENCES

1. "PIC12F635/PIC16F636/639 Data Sheet" (DS41232); Microchip Technology Inc.
2. AN959, "Using the PIC16F639 MCU for Smart Wireless Applications" (DS00959); Microchip Technology Inc.
3. TB088, "PIC16F639 Microcontroller Overview" (DS91088); Microchip Technology Inc.

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