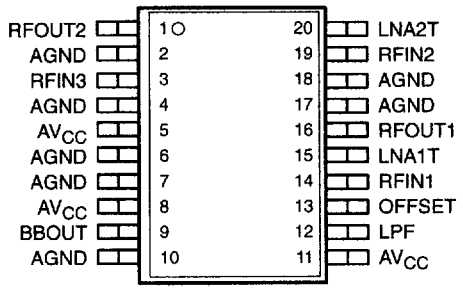
- **Wide VHF/UHF Frequency Range . . . 200 MHz to 450 MHz for World-Wide Remote Control Frequency Compatibility**
- **High Receiver Sensitivity . . . –102 dBm at 315 MHz**
- **Accepts Baseband Data Rates from 500 Hz to 10 kHz**
- **TRF (Tuned Radio Frequency) Design Eliminates Local Oscillator (No Emissions) and Reduces Many Government Type-Approvals (Including FCC)**
- **No Mixing Products Result in No Image to Reject**
- **Internal Amplifier and Comparator for Amplification and Shaping of Low-Level Input Signals with Average-Detecting Autobias Adaptive Threshold Circuitry for Improved Sensitivity**
- **Minimum External Component Count and Surface-Mount Packaging for Extremely Small Circuit Footprint – Typically Replaces more than 40 Components in an Equivalent Discrete Solution**
- **No Manual Alignment When Using SAW Filters**
- **Advanced Submicron BiCMOS Process Technology for Minimum Power Consumption**

description

The TRF1410 VHF/UHF RZ ASK Remote Control Receiver is a member of the MARCSTAR (Multichannel Advanced Remote Control Signalling Transmitter and Receiver) family of remote control serial data devices specifically designed for RZ ASK (Return-to-Zero Amplitude-Shift Keyed) communications systems operating in the 200 MHz – 450 MHz band. This device is targeted for use in automotive and home security systems, garage door openers, remote utility metering, and other low-power remote control and telemetry systems.

A complete RZ ASK receiver solution on a chip, the TRF1410 requires only a minimum of external components for operation. This significantly reduces the complexity and footprint of new designs compared with current discrete receiver designs. The TRF1410 requires no manual alignment when using external SAW (surface acoustic wave) filters. For a lower cost solution, the device is also compatible with external LC components.

DW PACKAGE
(TOP VIEW)



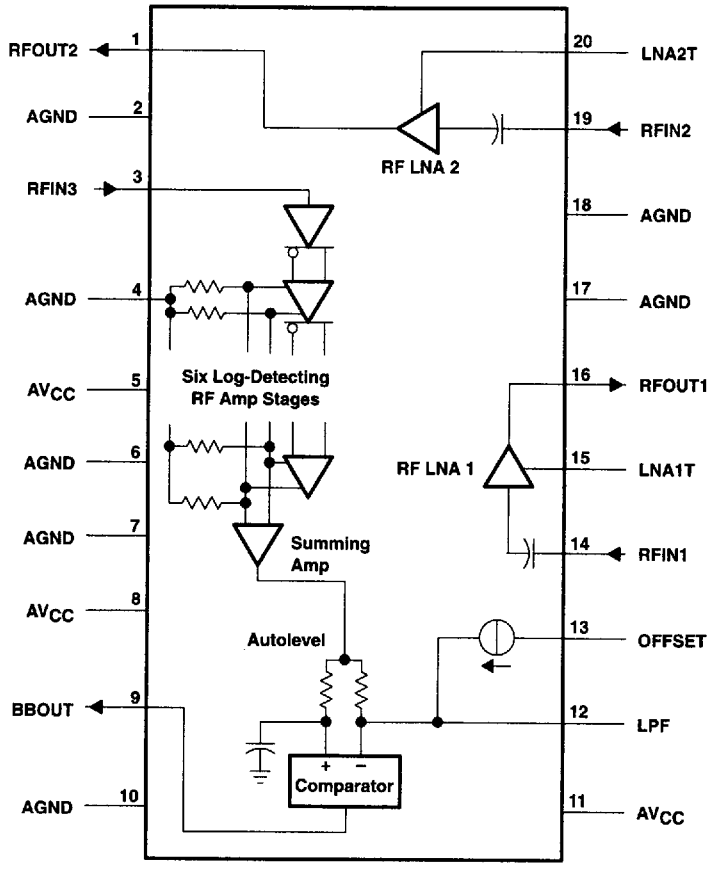
The TRF1410 also includes several on-chip features that would normally require additional circuitry in a receiver system design. These include two low-noise front-end amplifiers, an RF amplifier/comparator for detection and shaping of input signals, and a demodulated RZ ASK baseband TTL-level output that readily interfaces to self-synchronizing devices such as the TI rolling-code MARCSTAR decoder (TRC1300/TRC1315).

PRODUCT PREVIEW

description (continued)

The TRF1410 VHF/UHF RZ ASK remote control receiver is available in a 20-pin SOIC (DW) package, and is characterized for operation over the temperature range of –40°C to 85°C. The DW package is available taped and reeled. Add R suffix to device type (e.g., TRF1410R).

functional block diagram



PRODUCT PREVIEW

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
AGND	2, 4, 6, 7, 10, 17, 18		Analog ground for all internal analog circuits. All analog signals are referenced to these terminals.
AV_{CC}	5, 8, 11		Positive power supply voltage for all analog circuits — 4.5 V to 5.5 V.
BBOUT	9	O	Baseband data output. This is the demodulated envelope of the recovered RF signal. BBOUT is active with any received ASK signal coding format.
LNA1T	15		Low-noise amplifier (LNA) #1 ground termination. LNA1T should be connected to AGND through a parallel resistor-capacitor bias network. If left unconnected, the LNA is disabled.
LNA2T	20		Low-noise amplifier (LNA) #2 ground termination. LNA2T should be connected to AGND through a parallel resistor-capacitor bias network. If left unconnected, the LNA is disabled.
LPF	12		External low-pass capacitor used in the average-detecting adaptive threshold circuitry.
OFFSET	13		Connection to external offset resistor. This resistor (1 MΩ suggested) sets the internal threshold detector offset voltage. Lowering the value of this resistor decreases device sensitivity.
RFIN1	14	I	RF input to first low-noise, high-gain amplifier stage.
RFIN2	19	I	RF input to second low-noise, high-gain amplifier stage.
RFIN3	3	I	RF input to the detecting RF amplifier stages. Filtered RF in the form of AM RZ ASK data at frequencies between 200 MHz and 450 MHz, at a baud rate between 500 Hz and 10 kHz can be applied to this terminal for detection and decoding.
RFOUT1	16	O	RF output of the first low-noise, high-gain amplifier.
RFOUT2	1	O	RF output of the second low-noise, high-gain amplifier. Typically, the input of an external SAW or LC filter is connected to this terminal.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, AVCC, DVCC (see Note 1) ..... −0.6 to 6
Input voltage range, V_I ..... −0.6 to 6
Continuous total power dissipation ..... 180 mW
Operating free-air temperature range, T_A ..... −55°C to 85°C
Storage temperature range, T_{stg} ..... −65°C to 150°C
ESD protection, all terminals: human body model ..... 2 kV
machine model ..... 200 V
JEDEC latchup ..... 150 mA or 11 V

† 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.

NOTE 1: Voltage values are with respect to GND.

recommended operating conditions

	MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}	4.5		5.5	V
Input frequency, f_{in}	200		450	MHz
Operating free-air temperature, T_A	−40		85	°C
Minimum permissible AM modulation of RF envelope, measured at −102 dBm at RFINPUT		25%		

electrical characteristics over recommended ranges of supply voltage and operating free-air temperature, typical values are at f_{in} = 315 MHz, V_{CC} = 5 V, and T_A = 25°C (unless otherwise noted)

current consumption

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
I_{CC}	Average supply current from V_{CC}	I/O pins terminated with typical loads		3	mA

digital interface

PARAMETER			TEST CONDITIONS	MIN	MAX	UNIT
V_{OH}	High-level output voltage	BBOUT	I_{OH} = 3.2 mA	V_{CC}−0.5		V
V_{OL}	Low-level output voltage		I_{OL} = −3.2 mA		0.5	V

VSWR (voltage standing-wave ratio), ripple rejection

PARAMETER	MIN	TYP	MAX	UNIT
VSWR into 50 Ω (requires external LC matching network), RFIN1, RFOUT1, RFIN2, RFOUT2, RFIN3		2:1		V/V
Ripple rejection, 1 MHz (injected at AV_{CC} and DV_{CC}), measured at BBOUT while maintaining BER = 3/100 with desired carrier at −50 dBm (see Note 2)		6% V_{CC}		

NOTE 2: BER (bit error rate — errors/number of bits) is qualified by integration of logic-level pulses (>50% high = 1, <50% low = 0).

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RF sensitivity/overload

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
RF input (average) at test board RF input required for BER 3/100 (see Note 2) at 5 kHz baseband data rate	V_{CC} = 5 V, T_A = 25°C, f_{in} = 315 MHz, external SAW preselector bandpass filter (see Note 3)			–102	dBm
Overload signal at fc with BER 3/100 at 5 kHz (see Note 2) baseband data rate	V_{CC} = 5 V, T_A = 25°C, f_{in} = 315 MHz		–20		dBm

NOTES: 2. BER (bit error rate = errors/number of bits) is qualified by integration of logic-level pulses (>50% high = 1, <50% low = 0).
3. The SAW bandpass filter must have a rejection level greater than or equal to 50 dB at ±0.5 fc, insertion loss of less than or equal to 3 dB, and a –3 dB passband width of 0.2% fc.

timing requirements

RF input data (see Figure 1)†

		MIN	MAX	UNIT
t_r	Rise time, RF input data		0.1 t_{c1}	µs
t_f	Fall time, RF input data		0.1 t_{c1}	µs

† t_{c1} is the duration of the modulated RF carrier.

received data

		MIN	MAX	UNIT
	Baseband data frequency AM RZ ASK	0.5	10	kHz

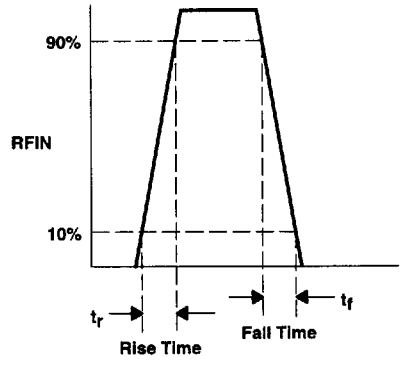

Figure 1. RFIN1 Rise and Fall Times

PRINCIPLES OF OPERATION

general

The TRF1410 VHF/UHF RZ ASK Remote Control Receiver demodulates AM RZ ASK modulated RF carriers between 200 MHz and 450 MHz with a 500-Hz to 10-kHz baseband data rate.

signal reception

The RF signal is collected by an antenna and then passed through an LC matching network to band-pass filter the signal and compensate for various antenna loading impedances. The signal is then input to the RFIN1 terminal of the TRF1410.

signal path through device

The RF signal applied to the RFIN1 terminal is amplified by LNA1 and LNA2. The combined gain of the two LNAs is 40 dB, with a 1-dB compression point of –80 dBm, and a noise figure of 5 dB (nominal). The amplified signal is output at RFOUT2 and enters an external preselector band-pass filter before being applied to the third stage of amplification at terminal RFIN3.

The third stage of amplification consists of a single-ended-input to differential-output amplifier followed by six high-gain differential log-detecting amplifier stages with an equivalent gain of 60 dB (nominal). First, the signal is converted to a differential signal for increased noise immunity. Next, the differential signal is passed through the six high-gain differential log-detecting amplifiers, forming a detection circuit. Each log-detecting amplifier is biased such that when an RF signal is present, an imbalance is caused in its bias circuit. The imbalance in each of the six stages is converted to a voltage and then summed into a baseband envelope representation of the RF signal. This signal then passes through an autoleveling circuit before being applied to a comparator to produce the TTL-level baseband signal output that appears at BBOUT. An external low-pass filter connected to BBOUT attenuates high-frequency transients in the output signal.

frequency adjustment

The TRF1410 requires no manual alignment. The receive frequency is dependent only on the choice of external matching networks and preselecting filters used. In that respect, the user has only to stock a different set of external components for each frequency, and no manual alignment or end-of-line frequency programming need be performed.

decoder interface

The TRC1300/1315 four-function, 40-bit rolling-code decoder can be interfaced directly to the TRF1410 using the baseband-data output (BBOUT) of the device. The TRC1300/1315 decodes the received data into instructions that it then executes.

external components and device performance

While the TRF1410 uses a minimum of external components in the typical application, the choice of those components greatly affects the performance of the device. When a SAW preselector is used, the selectivity (out-of-band rejection) and sensitivity of the TRF1410 are optimized as a result of the high Q of the SAW devices. If an LC preselector is used, these parameters change and the overall performance of the TRF1410 is reduced, but can still meet the requirements of many end-equipment applications.

An external resistor connected between OFFSET and ground adjusts the internal offset voltage of the receiver decoding section to maximize the noise rejection of the device. While a 1-MΩ resistor is suggested, this value can be changed to minimize toggling of output BBOUT during periods of nonvalid received code.

PRODUCT PREVIEW

APPLICABLE REGULATIONS

Receiver design, as well as transmitter design, is regulated throughout the world. Since the TRF1410 is targeted for world-wide sales, the applicable standard for each region must be considered when the device is to be used in systems to be successfully marketed in that region. For this reason, the TRF1410 conforms to all requirements shown in Figure 2 and Table 1. The primary specifications of most of the standards address carrier frequency and spurious emissions.

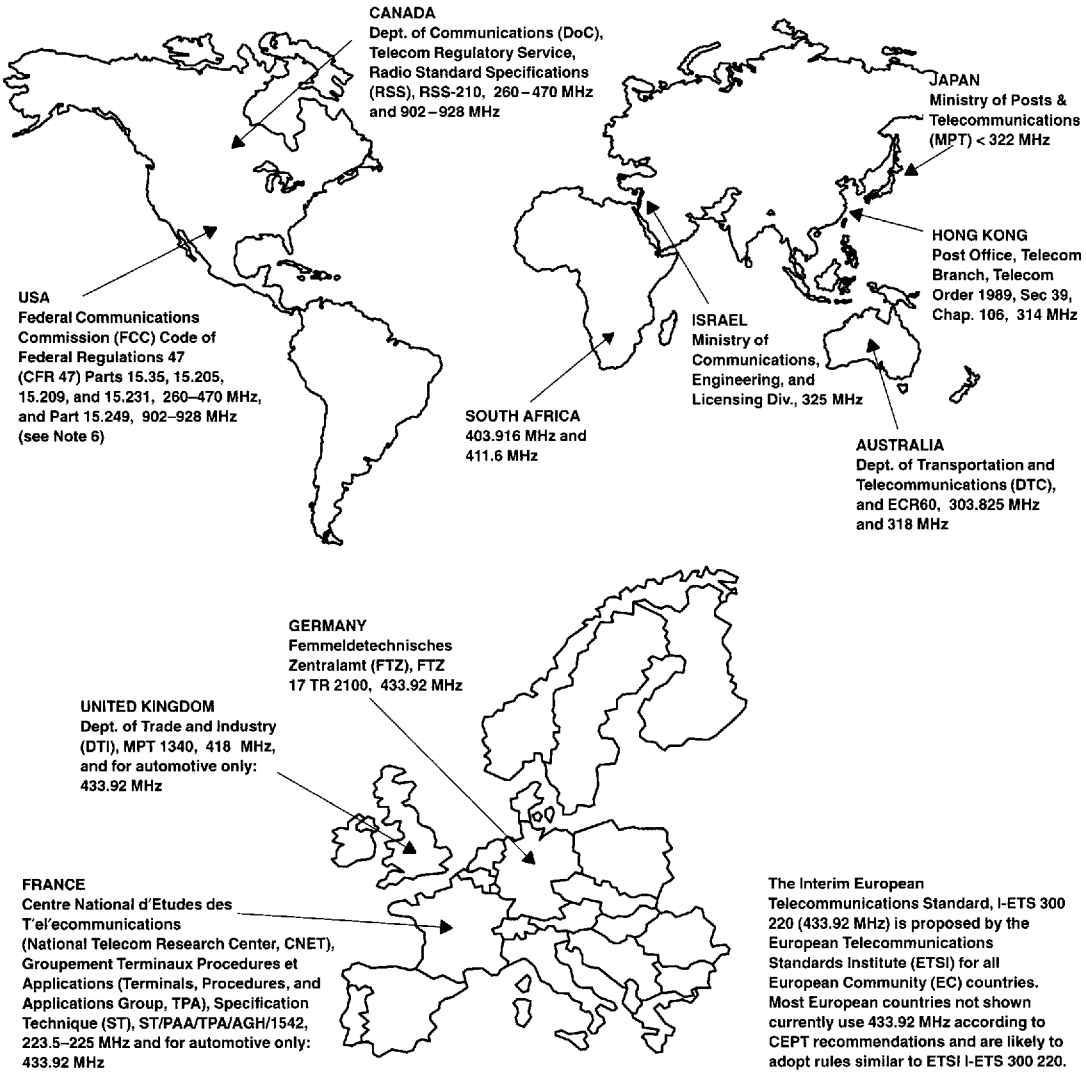

Figure 2. World-Wide Receiver Regulations

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APPLICABLE REGULATIONS

Table 1. World-Wide Regulations

REGION	REGULATION	FREQUENCY
USA	Federal Communications Commission (FCC) Code of Federal Regulations 47 (CFR 47) Parts 15.35, 15.205, 15.209, 15.231, and 15.249 (see Note 4)	260–470 MHz (Part 15.35, 15.205, 15.209) 902–928 MHz (Part 15.249, see Note 4)
Germany	Femmeldetechnisches Zentralamt (FTZ), FTZ 17 TR2100	433.92 MHz
France	Centre National d'Etudes des T'el'ecommunications (National Telecom Research Center, CNET), Groupement Terminaux Procedures et Applications (Terminals, Procedures and Applications Group, TPA), Specification Technique (ST), ST/PAA/TPA/AGH/1542	233.5–225 MHz (automotive only)
United Kingdom	Dept. of Trade and Industry (DTI), MPT 1340	418 MHz 433.92 MHz (automotive only)
Japan	Ministry of Posts and Telecommunications (MPT)	< 322 MHz
Canada	Dept. of Communications (DoC), Telecom Regulatory Service, Radio Standard Specifications (RSS), RSS-210	260–470 MHz (RSS-210) 902–928 MHz
Hong Kong	Post Office, Telecom Branch, Telecom Order 1989, Sec 39, Cap. 106	314 MHz
Australia	Dept. of Transportation and Telecommunications (DTC), and ECR60	303.825 MHz and 318 MHz
Israel	Ministry of Communications, Engineering & Licensing Div.	325 MHz
South Africa		403.916 MHz and 411.6 MHz

NOTE 4: Although the FCC Part 15.231 allows low-power unlicensed radios in the range of 260 MHz to 470 MHz, not all frequencies in this range are desirable. This is due to emission restrictions applying to fundamentals and harmonics in various forbidden bands as defined in Parts 15.205 and 15.209. USA frequencies shown above conform to these additional restrictions and are commonly used in the USA. Under Part 15.249, transmitters may continuously radiate 50 000 μV/m at 3 meters with simple modulation. Part 15.247 permits still higher power, but must use true spread-spectrum modulation. See FCC CFR 47, Part 47, Part 15 for details.