WCI 4051 QAM Demodulator Data Sheet

WCI 4051A QAM Demodulator

- **Up to 20 Msymbol Rate**
- **All Digital Carrier Recovery and Symbol Timing Architecture**
- **QPSK, 8 to 256-QAM, 8 and 16-PSK Modulation Formats**
- **Error Free 10-bit Fs/4 Digital Down Conversion (Optional 8-Bit or 12-Bit A/Ds available upon request)**
- **Programmable Coefficients Permit 10% to 90% Excess Bandwidths with a Minimum 63-Tap Nyquist Filter**
- **Complex Baseband Equalizer w/ Feed Forward Equalizer Operating in a T/2 Fractional Mode**
- **Coarse Frequency Tuning Automatically Adjusts to Large Frequency Offsets**
- **PWM AGC Accommodates 40 dB Dynamic Range**
- **Full Control and Status to Host PC Via RS-232 Link**
- **Fast All Digital Carrier Recovery (< 50 msec)**
- **1U Rack Mountable (Optional)**
- **8 Bit Symbol Output Interface with 3-Bit Soft Decision**
- **Optional Reed-Solomon or Trellis FEC**
- **Designed for <1 dB from Theoretical BER Implementation Loss**

The WCI 4051A QAM demodulator is a flexible, high performance QAM demodulator capable of operation up to 20 Mbaud. The demodulator features an all digital carrier recovery and symbol timing architecture, automatic gain control. Its compact form factor, low power usage make it ideal for applications such as digital TV Set-Top box development, HDTV test equipment development, cable modem development and line of sight microwave receiver applications.

<u>Demodulator Data Rates.</u> The WCI 4051A QAM demodulator architecture for symbol timing and carrier recovery is all digital. The WCI 4051A QAM demodulator supports programmable constellations and symbols rates up to 20 Mbaud. The constellations and symbol rates are as follows:

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Modulation	Data Rates	Bits Per Symbol
QPSK (4-QAM)	40 Mbps	2-Bits Per Symbol
8-PSK	60 Mbps	3-Bits Per Symbol
16-PSK	80 Mbps	4-Bits Per Symbol
8-QAM	60 Mbps	3-Bits Per Symbol
16-QAM	80 Mbps	4-Bits Per Symbol
32-QAM	100 Mbps	5-Bits Per Symbol
64-QAM	120 Mbps	6-Bits Per Symbol
128-QAM	140 Mbps	7-Bits Per Symbol
256-QAM	160 Mbps	8-Bits Per Symbol

Digital Resampling. The WCI 4051A QAM demodulator digitally resamples the incoming signal to produce 4+ samples / symbol prior to digital downconversion, Nyquist filtering, equalization, and carrier recovery. The input signal to the digital resampler is a buffered version of the A/D samples with up to 10-bit samples and either 2's complement or offset binary format. The digital resampler outputs 12-bit samples as a minimum. The ADC sample rate is 4 times the baud (symbol) rate.

Digital Down Conversion. The WCI 4051A QAM demodulator accepts digital inputs representing a signal whose frequency is Fs/4 + delta (Fs/4 downconversion). Fs is the resampled rate of the A/D converter after the digital resampler. The use of a digital down conversion as the last step before conversion to and from complex baseband eliminates any I & Q quadrature error or imbalance as a result of the digital modem. The inputs to the digital down conversion are a minimum of 10-bits. The digital down conversion outputs 12-bit samples as a minimum. The upper or lower sideband of the spectrum may be obtained (spectrum inversion).

Nyquist Filters. The WCI 4051A QAM demodulator supports programmable coefficients, permitting excess bandwidths in a range of 10 - 90%. The number of taps is at least 63. The Nyquist filters accepts as a minimum 10-bit inputs. The outputs of the Nyquist filters is a minimum of 12-bits.

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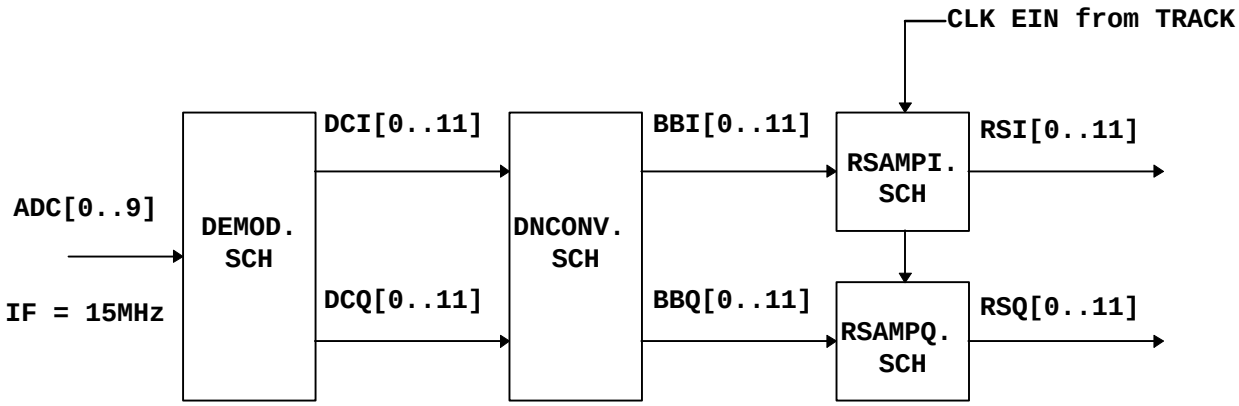

Description:
- GC3021 Based
- Converts to Baseband
- Real to Complex
- Config from TMS320C44

Description:
- GC2011 Based
- Nyquist Filters
- 32 Taps I
- 32 Taps Q
- Config from TMS320C44

Description:
- GC3011 Based
- Digital Resampler
- Clock Loop Filter
- Config from TMS320C44

Symbol Timing Recovery. The WCI 4051A QAM symbol timing recovery is performed through a proprietary all digital technique. This technique will permit operation utilizing a fixed rate A/D sample clock. The inputs to the symbol timing recovery are a minimum of 12-bits. The outputs from the symbol timing recovery is a 1-bit error value and an error valid signal.

Equalizer Operation. The equalizer operates at complex baseband, consisting of a minimum of 16 taps to cancel multipath, channel distortion and perform slope equalization. The equalizer is be configured as a forward feedback equalizer (FFE) operating in a T/2 fractional mode.

Coarse Frequency Adjustment. The QAM demodulator detects and measure large frequency offsets and issue requests to retune the downconverter to relocate the signal fully within the Nyquist bandwidth. This ensures optimal demodulation.

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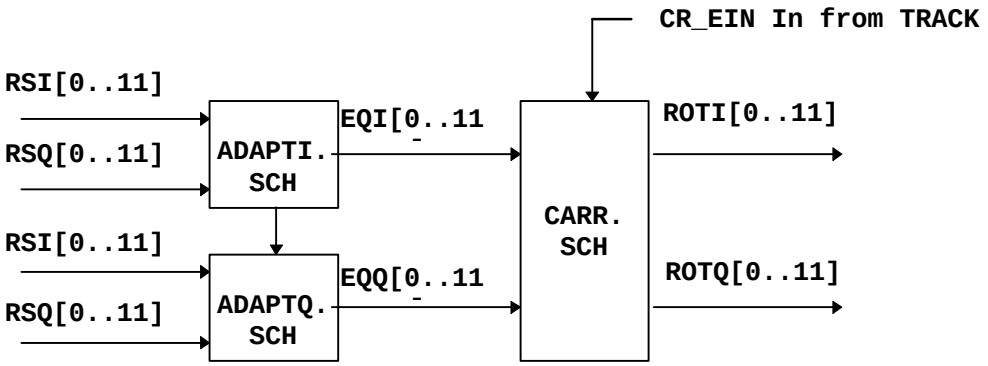

Description:
- -GC2011 Based
- -Adaptive Complex FIR
- -Config and Updates from TMS320C44

Description:
- -GC3021 Based
- -Removes Residual Freq Error
- -Symbols Out
- -Config from TMS320C44

Carrier Recovery. The WCI 4051A QAM demodulator provides an all digital carrier recovery capable of acquiring a signal within 50 msecs. The maximum carrier offset will be ± 1% of the symbol rate. Higher offsets can be accommodated with longer acquisition times by successive acquisition attempts with different frequency offsets.

AGC. The WCI 4051A QAM demodulator provides an AGC control that consists of a single-bit pulse width modulated (PWM) signal for adjusting RF and IF gains. The input to the AGC is provide by the A/D converter samples. The AGC accommodates 40 dB of dynamic range.

Symbol Output Interface. The WCI 4051A QAM demodulator provides 8-bit I and Q symbols to the FEC core block (currently available as an add on daughter board from Wideband). The 8-bit symbols provide a minimum of 3-bit soft decision when operating in 256-QAM. The symbols and recovered clock are provided at TTL levels.

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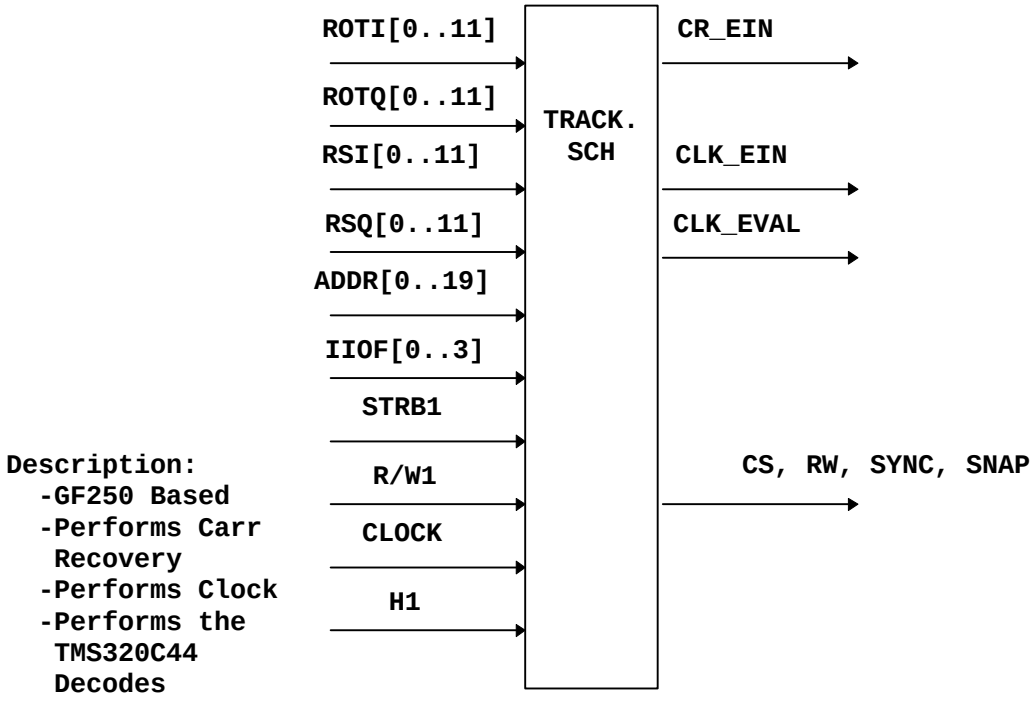

Control and Status Interface. The QAM demodulator control and status is be provided via serial RS-232 host interface operating at 2,400 BPS. All control and status values available are accessed via this interface. This interface is compatible with the selected host interface for the chip. The QAM-4051A demodulator controls include the following control and status values:

Configurable Control Values	Status Values Reported
Resampling ratio	Carrier lock status
AGC nominal value	Constellation error
Modulation format	BER estimation
Symbol timing loop constants	SNR estimation
Equalization modes (Blind and	Measured carrier frequency

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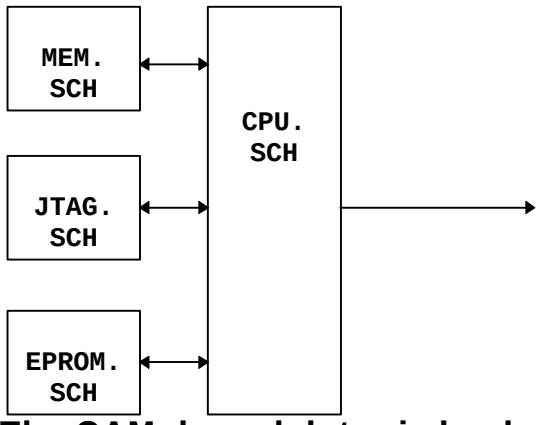
DDE)	offset
Equalization constants	Equalizer tap values
Carrier loop constants	Resampler state
Carrier offset	Resampler outputs
Nyquist filter values	Nyquist filter outputs
	Equalizer outputs



BER Performance. The QAM demodulator is be designed with a goal of achieving an implementation loss of less than 1 dB for QPSK, 16-QAM, 64-QAM and 256-QAM.

Power. Power is approximately 25 watts at 20 Mbaud operation.

Physical. The QAM demodulator is delivered in a 1U rack mount chassis or optionally as a standalone board for internal lab use. The connector scheme is as follows:

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Connector	Parameters
IF	SMA (70 MHz)
Host I/F	9-Pin Din (RS-232)
Data Out	50-Pin Din (TTL)
AGC Out	SMA (0 - 5V)
Power	Approximately 25 watts

FEC Option. The QAM demodulator provides for the future addition of an FEC decoder of the user's choice. Currently, a combined FEC Reed Solomon Encoder and Decoder board is optionally available. The FEC accepts byte wide words and clock and TTL levels. Also, a Trellis Decoder and Encoder daughter board is also available.

Parameters Reported From DSP

The Demodulator DSP (TMS320C44) currently computes the following parameters and returns them back to the user:

- Constellation Error Power
- AGC Output
- State of Convergence (Blind, Decision Directed)

Optionally, the DSP may be instrumented with software to output the following parameters but this will result in slightly decreased performance :

- Display the equalizer output spectrum
- Output the equalizer tap values
- Output the FFT of the equalizer taps
- Carrier and symbol track jitter

Convergence Time

Unsure if the proposed modem will converge fast enough for your application? Wideband Computers can run computer simulations of convergence times if you can provide us with a description of

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acceptable test cases describing your proposed modem environment. Items such as the following would be helpful:

- **Modulation Type, Multipath (Relative Level and Delay and Number of Paths)**
- **Echo Parameters**
- **Eb/No**
- **Initial Carrier Frequency and Symbol Rate Offsets From Nominal**

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