PCI Decoders

Application Note – Customizing PCI Decoder Drivers for Different Tuners

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PCI Decoders

Introduction

The purpose of this application note is to explain the programming details of various tuners and show the reader how to customize the software included in our PCI decoder Software Development Kit to enable control of different tuners for video standards worldwide.

The software included with our PCI Software Development Kit will work in the US without any modifications. However, due to differences in video channel frequencies and video standards around the world, it is necessary to modify the software to support tuners in other parts of the world. It is assumed that the reader has a working knowledge of C++ programming and the software tools necessary to compile the source codes.

PCI Decoder Software Development Kit Tuner support

The PCI Decoder Software Development Kit includes support for NTSC versions of Temic, Philips (FM1236) and Alps (TSCH5) tuners.

The programming of the above tuners is set up to operate via the I^2C bus. The I^2C bus uses both the SDA (Serial Data Line) and the SCL (Serial Clock Line) lines to transfer data in a serial fashion. In all cases, the PCI decoder acts as the master and the tuner acts as the slave. For more information on I^2C, refer to Rockwell's I^2C Reference guide.

I^2C Bus Data Format for Tuners

It is necessary to understand the I^2C bus data format for tuners before you can program them correctly. There are 4 sets of information that is needed by the tuners. They are the following:

- Address Byte
- 2 Divider Bytes
- Control Byte
- Bandswitch Byte

Most tuners follow the format given in Table 1 below. The exact data format for your tuner may vary.

Table 1. I 2C Data Format for Tuners

	MSB							LSB
Address Byte	1	1	0	0	0	MA1	MA0	0
Divider Byte 1	0	N14	N13	N12	N11	N10	N9	N8
Divider Byte 2	N7	N6	N5	N4	N3	N2	N1	N0
Control Byte	1	CP	T2	T1	T0	RSA	RSB	OS
BandSwitch Byte	P7	P6	P5	P4	P3	P2	P1	P0

Address Byte

The Address Byte is used to specify the I^2C address of the tuner. Some tuners have fixed I^2C address and some tuners have configurable I^2C address. The exact Address Byte format will be given in the tuner's data sheet. Check your tuner's data sheet for the exact address byte format, as it is non-standard.

If the I^2C address of the tuner is configurable, it means that the I^2C address of the tuner depends on how the tuner is set up in hardware. As an example, Table 1 shows two configurable address bits MA1 and MA0 in the Address byte. To correctly address the tuner, you must specify the address byte based on the hardware setting. Please refer to your tuner data sheet to find out how to setup your tuner's I^2C address.

Divider Bytes

The two Divider Bytes are used to instruct the tuner's PLL to synthesize various frequencies. With the ability to change the PLL frequency, you will be able to tune in to all the channels available via broadcast or cable television. Since the audio and video frequency spectrums for broadcast and cable TV are different for most countries around the world, each broadcast standard will require a different set of Divider bytes values.

Control Byte

The Control Byte specifies a charge pump (CP) setting, a test mode ([T2..T0]) setting, as well as the reference divider ratio (RSA, RSB) for the tuner. You can setup the tuner to tune faster or in smaller step size as well as put the tuner in test mode using the Control Byte. You can also shut down the PLL of the tuner using the Control Byte (OS).

Bandswitch Byte

The Bandswitch Byte is used to select one of the three frequency bands, namely, VHF Low, VHF High and UHF bands supported by all tuners. Each television channel (broadcast or cable) will belong to only one band. To correctly tune to any channel, it is necessary to specifying the correct Divider Bytes and the frequency band that the channel belongs to.

The channel assignments for the various frequency bands depend on the broadcast standard. For example, the channel assignments for NTSC Japan are different from the channel assignments for NTSC (M) and PAL B. Please refer to Rockwell's Application Note on "Broadcast and Cable Television Frequency Standards" for further details.

How to Derive the Divider Bytes

The trickiest part about deriving the Divider Bytes is that you will need to obtain the table of frequencies for the country that you wish to support. Please refer to the Rockwell Application Note on "Broadcast and Cable Television Frequency Standards" for further information.

Table 2. Divider Bytes

Divider Byte 1	0	N14	N13	N12	N11	N10	N9	N8
Divider Byte 2	N7	N6	N5	N4	N3	N2	N1	N0

Refer to the Divider Bytes above. You will see that the least significant bit is N0 followed by N1, N2 and so on. The most significant bit is N14. N0 through N14 are binary bits, meaning each of them can only be either a 1 or a 0.

How does one derive the values for N0 through N14? In every tuner data sheet, you will find a formula stating the relationship between the frequency of oscillation and the value N. Be aware that the formula is dependent on the tuner and it is non-standard. The NTSC tuners from Philips and Temic that we support, both have the same formula as follows:

$$F_{osc} = N/16 \text{ (Mhz)}$$

Rearranging the above equation, we get the following:

$$N = 16 * F_{osc}$$

The frequency of oscillation is made up of two components; they are the Radio Frequency and the Intermediate Frequency. The relationship is as follows:

$$F_{osc} = F_{IF} + F_{RF}$$

The frequency of oscillation depends on the channel number. To better illustrate this, an example calculation follows. Suppose you are using a Temic 4032FY5 (NTSC) tuner and you wish to find out the frequency of oscillation for broadcast channel 2 in the United States. The Intermediate Frequency of the tuner as specified in the tuner data sheet is 45.75 Mhz. The video carrier frequency for broadcast channel 2 is 55.25 Mhz, so the Radio Frequency F_{RF} to use is 55.25 Mhz.

```
Channel Number = 2
F_IF =  45.75 Mhz  (obtained from 4032FY5 data sheet)
F_RF =  55.25 Mhz  (video carrier frequency for Channel 2)
```

The Frequency of oscillation is obtained by summing F_{IF} and F_{RF} :

$$F_{osc} = F_{IF} + F_{RF} = 45.75 + 55.25 \text{ Mhz} = 101 \text{ Mhz}$$

It is very straightforward to derive the value of N once you know the frequency of oscillation:

```
N = 16 * F_osc
= 16 * 101
= 1616   (Decimal)
= 0x0650 (hex)
= 000011001010000 (Binary)
```

Therefore:

```
N14= 0
N13= 0
N12= 0
N11= 0
N10= 1 etc.
```

It is important to note that the Intermediate Frequencies of different types of tuners are different. Take for instance, the Intermediate Frequency of the Philips FI1236 (NTSC) tuner is 45.75 Mhz whereas the Intermediate Frequency of the Philips FM1246 PAL-I tuner is 38.90 Mhz. You must refer to the appropriate data sheet to determine the Intermediate Frequency of your tuner. Table 3 below lists all the N values for NTSC (M) broadcast television for the Temic 4032FY5 tuner.

Table 3. Table of N Values for NTSC (M) Broadcast TV (Temic4032FY5 Tuner)

Channel	F_{RF} (MHz)	F_{IF} Tuner (MHz)	F_{OSC} (MHz)	N (16 * F_{OSC})	N (Hex)
2	55.25	45.75	101	1616	0650
3	61.25	45.75	107	1712	06B0
4	67.25	45.75	113	1808	0710
5	77.25	45.75	123	1968	07B0
6	83.25	45.75	129	2064	0810
7	175.25	45.75	221	3536	0DD0
8	181.25	45.75	227	3632	0E30
9	187.25	45.75	233	3728	0E90
10	193.25	45.75	239	3824	0EF0

Table 3. Table of N Values for NTSC (M) Broadcast TV (Temic4032FY5 Tuner) (Continued)

11	199.25	45.75	245	3920	0F50
12	205.25	45.75	251	4016	0FB0
13	211.25	45.75	257	4112	1010
14	471.25	45.75	517	8272	2050
15	477.25	45.75	523	8368	20B0
16	483.25	45.75	529	8464	2110
17	489.25	45.75	535	8560	2170
18	495.25	45.75	541	8656	21D0
19	501.25	45.75	547	8752	2230
20	507.25	45.75	553	8848	2290
21	513.25	45.75	559	8944	22F0
22	519.25	45.75	565	9040	2350
23	525.25	45.75	571	9136	23B0
24	531.25	45.75	577	9232	2410
25	537.25	45.75	583	9328	2470
26	543.25	45.75	589	9424	24D0
27	549.25	45.75	595	9520	2530
28	555.25	45.75	601	9616	2590
29	561.25	45.75	607	9712	25F0
30	567.25	45.75	613	9808	2650
31	573.25	45.75	619	9904	26B0
32	579.25	45.75	625	10000	2710
33	585.25	45.75	631	10096	2770
34	591.25	45.75	637	10192	27D0
35	597.25	45.75	643	10288	2830
36	603.25	45.75	649	10384	2890
37	609.25	45.75	655	10480	28F0
38	615.25	45.75	661	10576	2950
39	621.25	45.75	667	10672	29B0
40	627.25	45.75	673	10768	2A10
41	633.25	45.75	679	10864	2A70
42	639.25	45.75	685	10960	2AD0

Table 3. Table of N Values for NTSC (M) Broadcast TV (Temic4032FY5 Tuner) (Continued)

43	645.25	45.75	691	11056	2B30
44	651.25	45.75	697	11152	2B90
45	657.25	45.75	703	11248	2BF0
46	663.25	45.75	709	11344	2C50
47	669.25	45.75	715	11440	2CB0
48	675.25	45.75	721	11536	2D10
49	681.25	45.75	727	11632	2D70
50	687.25	45.75	733	11728	2DD0
51	693.25	45.75	739	11824	2E30
52	699.25	45.75	745	11920	2E90
53	705.25	45.75	751	12016	2EF0
54	711.25	45.75	757	12112	2F50
55	717.25	45.75	763	12208	2FB0
56	723.25	45.75	769	12304	3010
57	729.25	45.75	775	12400	3070
58	735.25	45.75	781	12496	30D0
59	741.25	45.75	787	12592	3130
60	747.25	45.75	793	12688	3190
61	753.25	45.75	799	12784	31F0
62	759.25	45.75	805	12880	3250
63	765.25	45.75	811	12976	32B0
64	771.25	45.75	817	13072	3310
65	777.25	45.75	823	13168	3370
66	783.25	45.75	829	13264	33D0
67	789.25	45.75	835	13360	3430
68	795.25	45.75	841	13456	3490
69	801.25	45.75	847	13552	34F0

How to Derive the Control Byte

Below is an example of the Control Byte with definitions for the various bits. Note that the format of the Control Byte may differ for different tuners.

Control Byte	1	CP	T2	T1	T0	RS A	RS B	OS

The least significant bit is OS and it is used to disable the PLL of the tuner.

OS =0 for normal operation
OS =1 for switching the charge pump to the high impedance state (disable the PLL)

The next two bits RSA and RSB are known as the Ratio Select bits. Depending on the tuner used, these two bits may or may not be fixed. If the tuner allows various step sizes then the tuner manufacturer will need to specify how to set them up. The following is a table given in the Philips FI1236MK2 tuner data sheet:

Table 4. Ratio Select Bits for Philips FI1236Mk2 Tuner

RSA	RSB	STEP size
X	0	50 Khz
0	1	31.25 Khz (for slow picture search)
1	1	62.5 Khz (for normal picture search)

The most important thing to note is that the Ratio Select bits are not standard. An example would be an ALPS TSB tuner, its data sheet does not even mention anything about the ratio select bits. The values for the two bits are 11 in binary. You must be very careful in order to get the tuner to work properly.

The next 3 bits T2, T1 and T0 are meant for setting the test mode of the tuner. Please refer to the tuner's data sheet for an explanation of the various test modes. In most cases, the tuner will be operating in normal mode defined as follows:

```
T2 = T1 = 0 and T0 = 1  (Or T2T1T0 = 001)
```

The next bit CP is defined as follows:
CP = 1 for fast tuning
CP = 0 for moderate speed tuning

Normally, the Control Byte is either 0xCE (11001110 in binary) or 0x8E (10001110 in binary) which means that the tuner is operating in normal mode with fast tuning or in normal mode with moderate tuning speed respectively. You must check the data sheet of the tuner that you wish to support to determine the actual value of the Control Byte.

How to Derive the Bandswitch Byte

The Bandswitch Byte is different for each tuner. You will need to refer to your tuner data sheet to determine the exact format for it. The only thing that is common for all tuners is that they all support three frequency bands. They are the following:

1. VHF Low
2. VHF High
3. UHF

The data sheet of each tuner will provide the frequency ranges of the three bands stated above. Some data sheet may state Low, Middle and High frequency bands but they mean the same as above.

Each frequency of oscillation (F_{osc}) will belong to only one band. In other words, each channel in broadcast or cable television will belong to only one band. Note once again that the frequency ranges depend on the tuner used. A detailed explanation can be found in the section Section , How to Specify the Channel Maps.

Modifying the Software Development Kit

This section specifies how to modify the Software Development kit for a different tuner control.

Finding the Actual File to Modify

It is necessary to modify the “grappler.dll” file supplied in the PCI Decoder Software Development Kit to change the Divider Bytes, Control Byte and Bandswitch Byte for tuners in different parts of the world. To do this, one must modify the “tuner.cpp” file given in the PCI Decoder Software Development Kit and recompile it to get a customized version of “grappler.dll”

In the PCI Decoder Software Development Kit, you will find a folder named “Source”:

```
Source
   |-------Grappler
   |-------Dialogs
   |-------Include
   |-------Lib
```

You will find the file “tuner.cpp” in the “Grappler” folder. The sections that follow will explain the modifications you need to make.

Modifying the Divider Bytes

Open the “tuner.cpp” file with your editor and look for the following code fragment:

```
//////////////////////////////////////////////////////////////
// Divider codes for NTSC USA Air Channels
//////////////////////////////////////////////////////////////
TunerCodes airNtscChannelCode[] = {
   0x0000, 0x0000, 0x0650, 0x06B0, 0x0710, 0x07B0,
   0x0810, 0x0DD0, 0x0E30, 0x0E90, 0x0EF0,
   0x0F50, 0x0FB0, 0x1010, 0x2050, 0x20B0,
   0x2110, 0x2170, 0x21D0, 0x2230, 0x2290,
   0x22F0, 0x2350, 0x23B0, 0x2410, 0x2470,
   0x24D0, 0x2530, 0x2590, 0x25F0, 0x2650,
   0x26B0, 0x2710, 0x2770, 0x27D0, 0x2830,
   0x2890, 0x28F0, 0x2950, 0x29B0, 0x2A10,
   0x2A70, 0x2AD0, 0x2B30, 0x2B90, 0x2BF0,
   0x2C50, 0x2CB0, 0x2D10, 0x2D70, 0x2DD0,
   0x2E30, 0x2E90, 0x2EF0, 0x2F50, 0x2FB0,
   0x3010, 0x3070, 0x30D0, 0x3130, 0x3190,
   0x31F0, 0x3250, 0x32B0, 0x3310, 0x3370,
   0x33D0, 0x3430, 0x3490, 0x34F0
};


//////////////////////////////////////////////////////////////
// Divider codes for NTSC USA Cable Channels
//////////////////////////////////////////////////////////////
TunerCodes cableNtscChannelCode[] = {
   0x0000, 0x0770, 0x0650, 0x06B0, 0x0710, 0x07B0,
   0x0810, 0x0DD0, 0x0E30, 0x0E90, 0x0EF0,
   0x0F50, 0x0FB0, 0x1010, 0x0A70, 0x0AD0,
   0x0B30, 0x0B90, 0x0BF0, 0x0C50, 0x0CB0,
   0x0D10, 0x0D70, 0x1070, 0x10D0, 0x1130,
   0x1190, 0x11F0, 0x1250, 0x12B0, 0x1310,
   0x1370, 0x13D0, 0x1430, 0x1490, 0x14F0,
   0x1550, 0x15B0, 0x1610, 0x1670, 0x16D0,
   0x1730, 0x1790, 0x17F0, 0x1850, 0x18B0,
   0x1910, 0x1970, 0x19D0, 0x1A30, 0x1A90,
   0x1AF0, 0x1B50, 0x1BB0, 0x1C10, 0x1C70,
   0x1CD0, 0x1D30, 0x1D90, 0x1DF0, 0x1E50,
   0x1EB0, 0x1F10, 0x1F70, 0x1FD0, 0x2030,
   0x2090, 0x20F0, 0x2150, 0x21B0, 0x2210,
   0x2270, 0x22D0, 0x2330, 0x2390, 0x23F0,
   0x2450, 0x24B0, 0x2510, 0x2570, 0x25D0,
   0x2630, 0x2690, 0x26F0, 0x2750, 0x27B0,
   0x2810, 0x2870, 0x28D0, 0x2930, 0x2990,
   0x29F0, 0x2A50, 0x2AB0, 0x2B10, 0x0890,
   0x08F0, 0x0950, 0x09B0, 0x0A10, 0x2B70,
   0x2BD0, 0x2C30, 0x2C90, 0x2CF0, 0x2D50,
   0x2DB0, 0x2E10, 0x2E70, 0x2ED0, 0x2F30,
   0x2F90, 0x2FF0, 0x3050, 0x30B0, 0x3110,
   0x3170, 0x31D0, 0x3230, 0x3290, 0x32F0,
   0x3350, 0x33B0, 0x3410, 0x3470, 0x34D0
};
```

This is where you find the Divider Bytes for the all US broadcast and Cable TV channels. You will need to Calculate the Divider Bytes for the video standard that your tuner is designed for. The

various Divider bytes for NTSC (M) and PAL (B,G) tuners are included as an appendix to this application note.

In the US, the first air channel starts from VHF low band and it is channel 2. Examine the first two 32-bit DWORD in the cableNtscChannelCode array, you will find 0x0000 in there. They are meant for channels 0 and 1 that are not used in the US. The third DWORD is meant for channel 2 and the value is 0x0650. The most significant byte of the DWORD is Divider Byte 1 and the least significant byte of the DWORD is Divider Byte 2. Therefore, Divider Byte 1 is 0x06 and Divider Byte 2 is 0x50.

If you are using your tuner in a PAL environment, you will need to make sure that you calculate the new Divider Bytes (values for PAL B,G are given in the appendix) and put them in two new arrays. You may choose to replace the default Divider Bytes with your own Divider Bytes. In this case, your version of grappler.dll will no longer support NTSC (M).

If you add two new arrays to the tuner.cpp file, it is necessary to modify the member methods GetDividerWord, SetDividerWord and MaxNumberOfChannel for the Tuner class to use the new Divider bytes that you have added. Details on how to modify the source code are beyond the scope of this Application Note.

Modifying the Control Byte and Bandswitch Byte

In the same “tuner.cpp” file, you will find the following code fragment:

```
//////////////////////////////////////////////////////////////////
ControlWord controlPhilips[] = // Philips FM1236 video & FM radio tuner
{   // These control bytes are for video only
   0xCEA0, // vhf low
   0xCE90, // vhf high
   0xCE30  // uhf
};

//////////////////////////////////////////////////////////////////
ControlWord controlTemic[] =
{
   0x8E02, // vhf low
   0x8E04, // vhf high
   0x8E01  // uhf
};

//////////////////////////////////////////////////////////////////
ControlWord controlAlps[] =      // Alps TSCH5 tuner with FM radio
{                               // These control bytes are for video only
   0xC214, // vhf low
   0xC212, // vhf high
   0xC211  // uhf
};
```

Each of the DWORD in the above 3 arrays is actually made up of Control Byte : Bandswitch Byte. For instance, in the controlPhilips ControlWord structure, there are 3 DWORDs 0xCEA0, 0xCE90 and 0xCE30, one for each band. 0xCE is the Control Byte and 0xA0 is the Bandswitch byte for the VHF low band. 0xCE is the Control Byte and 0x90 is the Bandswitch byte for the VHF high band.

As mentioned in the section Section , How to Derive the Bandswitch Byte, it is necessary for you to obtain the exact format of the Bandswitch byte from your tuner data sheet. With the exact Bandswitch format, you will be able to modify the Bandswitch bytes to work with your own TV tuner.

How to Specify the Channel Maps

Once again, in the file “tuner.cpp”, you will find the following code fragments:

```
////////////////////////////////////////////////////////////////
// Channel Map of frequency bands for NTSC USA air channels
////////////////////////////////////////////////////////////////
TunerBandStruct airNtscBands[] = {
    {  2,  6, bandVHF_LOW  },
    {  7, 13, bandVHF_HIGH },
    { 14, 69, bandUHF      },
    {  0,  0, 0            } // end marker
};

////////////////////////////////////////////////////////////////
// Channel Map of frequency bands for NTSC USA cable channels
////////////////////////////////////////////////////////////////
TunerBandStruct cableNtscBands[] = {
    {   1,   6, bandVHF_LOW  },
    {   7,  13, bandVHF_HIGH },
    {  14,  20, bandVHF_LOW  },
    {  21,  62, bandVHF_HIGH },
    {  63,  94, bandUHF      },
    {  95,  99, bandVHF_LOW  },
    { 100, 125, bandUHF      },
    {   0,   0, 0            }   // end marker
};

////////////////////////////////////////////////////////////////
// Channel Map of frequency bands for NTSC USA cable channels for Alps
// TSCH5
////////////////////////////////////////////////////////////////
TunerBandStruct AlpsCableNtscBands[] = {
    {   1,   6, bandVHF_LOW  },
    {   7,  13, bandVHF_HIGH },
    {  14,  15, bandVHF_LOW  },
    {  16,  47, bandVHF_HIGH },
    {  48,  94, bandUHF      },
    {  95,  99, bandVHF_LOW  },
    { 100, 125, bandUHF      },
    {   0,   0, 0            }   // end marker
};
```

The purpose of the channel maps is to map each channel number to one of the three frequency bands. Without the channel map, one cannot specify the correct Bandswitch byte when tuning to a specific channel.

You will need to refer to the data sheet of the tuner you are using to find out the frequency range for each of the three bands. Do not assume that the frequency range is the same for all tuners. The channel coverage chart in the tuner data sheet will specify the frequency range for the various bands. The following table is taken from the data sheet of the Temic 4036FY5 (NTSC) TV tuner. You will find something similar in most tuner data sheets.

Table 5. Channel coverage chart for Temic 4036FY5 (NTSC) tuner

Band	Channels (F_{RF})
Low band	54 to 157.25 MHz
Mid band	162.00 to 451.25 MHz
High band	456.00 to 801.25 MHz

Assuming that you are using a Temic 4036FY5 (NTSC) tuner and you wish to build a channel map for broadcast television in the United States. Table A.1 lists the video carrier frequencies for all NTSC (M) broadcast channels. Channels 2 through 6 have frequencies in the range of 55.25 MHz to 83.25 MHz, so they belong to the Low band. Channels 7 through 13 have frequencies between 175.25 MHz to 211.25 MHz which means that they belong to the Mid band. Channels 14 through 69 have frequencies in the range of 471.25 MHz to 801.25 MHz, so they belong to the High band.

In the airNtscBands array above, you will see that we have defined channels 2 through 6 in the VHF_LOW band, channels 7 through 13 in the VHF_HIGH band and finally channels 14 through 69 in the UHF band.

You have to add your own channel map arrays for the broadcast standard that you wish to support. Bear in mind that the channel coverage for different tuners and different broadcast standards are different. If you don't specify the bands according to the channel coverage chart of your tuner, you will not be able to tune to certain channels. For a complete list of frequency values for various video standards, please refer to Rockwell's Application Note "Broadcast and Cable Television Frequency Standards".

After you have added your own channel maps, make sure you modify the GetControlWord member method for the Tuner class to use your own channel map instead of the supplied one. A detailed explanation of how to modify the member method is beyond the scope of this application note.

Compiling the Code

Once you have added you own Divider Bytes arrays, Control Bytes and Bandswitch Bytes arrays and the channel maps arrays, you will need to re-compile tuner.cpp to generate a new grappler.dll file. Basically, you will need to make use of the make files supplied in the PCI Decoder Software Development Kit.

Upon successful compilation, you will get a new "grappler.dll" file which will support both NTSC and the television standard you have decided to use. If you choose to modify the various arrays above, you will end up with a new "grappler.dll" file which will only support the television

standard you have decided to use. Simply replace the original grappler.dll file with the new one. You can find the grappler.dll file in your windows\system directory.

Once you have tested the new grappler.dll file, you will need to modify your own driver installation program to use the new version. Another option is to replace the original grappler.dll file with your own version and distribute it with the rest of the PCI Decoder drivers.

Summary

In summary, to be able to support TV tuners for various video standards outside the United States, one must execute the following steps:

1. Determine which tuner you need to use for the video standard in the intended country of operation.
2. Get the data sheet for the tuner and make sure you know the I^2C data format of the tuner.
3. If the tuner data sheet does not provide a table for the Divider Bytes, you will need to calculate the divider byte values and build a table yourself. Refer to Rockwell's Application note on "Broadcast and Cable Television Frequency Standards" to find out the actual frequencies to use. You will need to find out the Intermediate Frequency of the tuner and calculate the frequency of oscillation for each channel.
4. Modify the "tuner.cpp" file that comes with the Rockwell PCI Decoder Software Development Kit. Make sure that you modify the various member methods for the Tuner class to point to the appropriate data structure that you set up for your TV tuner.
5. If you are using Borland C++ version 5.0 and above, use the "grappler.mak" make file to build a new version of the grappler.dll file.
6. If you are using Visual C++ 4.0 and above, use the "m_grappler.mak" make file to build a new version of the grappler.dll file.
7. Include the new grappler.dll in your own driver installation program.

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Appendix

Channel maps and divider bytes for different broadcast standards

NTSC (M) TV Broadcast

Table 6 lists the band assignment, video frequencies, and divider bytes for NTSC TV broadcast for a Temic 4036FY5 tuner. The actual Divider Bytes for your selected tuner may vary.

Table 6. I^2C Divider Bytes for NTSC (M) Broadcast TV (Temic 4036FY5 tuner)

Band Assignment	Channel Number	Video Carrier (MHz)	Divider Byte1	Divider Byte2
	2	55.25	06	50
VHF	3	61.25	06	B0
LOW	4	67.25	07	10
	5	77.25	07	B0
	6	83.25	08	10
	7	175.25	0D	D0
	8	181.25	0E	30
VHF	9	187.25	0E	90
HIGH	10	193.25	0E	F0
	11	199.25	0F	50
	12	205.25	0F	B0
	13	211.25	10	10
	14	471.25	20	50
	15	477.25	20	B0
UHF	16	483.25	21	10
	17	489.25	21	70
	18	495.25	21	D0
	19	501.25	22	30
	20	507.25	22	90

Table 6. I²C Divider Bytes for NTSC (M) Broadcast TV (Temic 4036FY5 tuner) (Continued)

	21	513.25	22	F0
	22	519.25	23	50
	23	525.25	23	B0
	24	531.25	24	10
	25	537.25	24	70
	26	543.25	24	D0
	27	549.25	25	30
	28	555.25	25	90
	29	561.25	25	F0
	30	567.25	26	50
	31	573.25	26	B0
	32	579.25	27	10
	33	585.25	27	70
	34	591.25	27	D0
	35	597.25	28	30
	36	603.25	28	90
UHF	37	609.25	28	F0
	38	615.25	29	50
	39	621.25	29	B0
	40	627.25	2A	10
	41	633.25	2A	70
	42	639.25	2A	D0
	43	645.25	2B	30
	44	651.25	2B	90
	45	657.25	2B	F0
	46	663.25	2C	50
	47	669.25	2C	B0
	48	675.25	2D	10
	49	681.25	2D	70
	50	687.25	2D	D0
	51	693.25	2E	30
	52	699.25	2E	90

Table 6. I²C Divider Bytes for NTSC (M) Broadcast TV (Temic 4036FY5 tuner) (Continued)

UHF	53	705.25	2E	F0
	54	711.25	2F	50
	55	717.25	2F	B0
	56	723.25	30	10
	57	729.25	30	70
	58	735.25	30	D0
	59	741.25	31	30
	60	747.25	31	90
	61	753.25	31	F0
	62	759.25	32	50
	63	765.25	32	B0
	64	771.25	33	10
	65	777.25	33	70
	66	783.25	33	D0
	67	789.25	34	30
	68	795.25	34	90
	69	801.25	34	F0

NTSC Cable TV

Table 7lists the band assignment, video frequencies, and Divider codes for NTSC Cable TV for a Temic 4036FY5 NTSC tuner. The actual Divider bytes for your selected tuner may vary

Table 7. I ^{2}C Divider Bytes for NTSC Cable TV (Temic 4036FY5 tuner)

Band Assignment	Channel Number	Video Carrier (MHz)	Divider Byte1	Divider Byte2
	1	73.25	07	70
	2	55.25	06	50
VHF	3	61.25	06	B0
LOW	4	67.25	07	10
	5	79.25	07	B0
	6	85.25	08	10
	7	175.25	0D	D0
	8	181.25	0E	30
	9	187.25	0E	90
VHF	10	193.25	0E	F0
HIGH	11	199.25	0F	50
	12	205.25	0F	B0
	13	211.25	10	10
	14	121.25	0A	70
	15	127.25	0A	D0
VHF	16	133.25	0B	30
LOW	17	139.25	0B	90
	18	145.25	0B	F0
	19	151.25	0C	50
	20	157.25	0C	B0
	21	163.25	0D	10
	22	169.25	0D	70
VHF	23	217.25	10	70
HIGH	24	223.25	10	D0
	25	229.25	11	30

Table 7. I 2C Divider Bytes for NTSC Cable TV (Temic 4036FY5 tuner) (Continued)

	26	235.25	11	90
	27	241.25	11	F0
	28	247.25	12	50
	29	253.25	12	B0
	30	259.25	13	10
	31	265.25	13	70
	32	271.25	13	D0
	33	277.25	14	30
	34	283.25	14	90
	35	289.25	14	F0
	36	295.25	15	50
	37	301.25	15	B0
	38	307.25	16	10
	39	313.25	16	70
	40	319.25	16	D0
	41	325.25	17	30
	42	331.25	17	90
VHF	43	337.25	17	F0
HIGH	44	343.25	18	50
	45	349.25	18	B0
	46	355.25	19	10
	47	361.25	19	70
	48	367.25	19	D0
	49	373.25	1A	30
	50	379.25	1A	90
	51	385.25	1A	F0
	52	391.25	1B	50
	53	397.25	1B	B0
	54	403.25	1C	10
	55	409.25	1C	70
	56	415.25	1C	D0
	57	421.25	1D	30

Table 7. I ^{2}C Divider Bytes for NTSC Cable TV (Temic 4036FY5 tuner) (Continued)

	58	427.25	1D	90
	59	433.25	1D	F0
VHF	60	439.25	1E	50
HIGH	61	445.25	1E	B0
	62	451.25	1F	10
	63	457.25	1F	70
	64	463.25	1F	D0
	65	469.25	20	30
	66	475.25	20	90
	67	481.25	20	F0
	68	487.25	21	50
	69	493.25	21	B0
	70	499.25	22	10
	71	505.25	22	70
	72	511.25	22	D0
	73	517.25	23	30
	74	523.25	23	90
UHF	75	529.25	23	F0
	76	535.25	24	50
	77	541.25	24	B0
	78	547.25	25	10
	79	553.25	25	70
	80	559.25	25	D0
	81	565.25	26	30
	82	571.25	26	90
	83	577.25	26	F0
	84	583.25	27	50
	85	589.25	27	B0
	86	595.25	28	10
	87	601.25	28	70
	88	607.25	28	D0
	89	613.25	29	30

Table 7. I 2C Divider Bytes for NTSC Cable TV (Temic 4036FY5 tuner) (Continued)

UHF	90	619.25	29	90
	91	625.25	29	F0
	92	631.25	2A	50
	93	637.25	2A	B0
	94	643.25	2B	10
VHF LOW	95	91.25	08	90
	96	97.25	08	F0
	97	103.25	09	50
	98	109.25	09	B0
	99	115.25	0A	10
UHF	100	649.25	2B	70
	101	655.25	2B	D0
	102	661.25	2C	30
	103	667.25	2C	90
	104	673.25	2C	F0
	105	679.25	2D	50
	106	685.25	2D	B0
	107	691.25	2E	10
	108	697.25	2E	70
	109	703.25	2E	D0
	110	709.25	2F	30
	111	715.25	2F	90
	112	721.25	2F	F0
	113	727.25	30	50
	114	733.25	30	B0
	115	739.25	31	10
	116	745.25	31	70
	117	751.25	31	D0
	118	757.25	32	30
	119	763.25	32	90
	120	769.25	32	F0
	121	775.25	33	50

Table 7. I 2C Divider Bytes for NTSC Cable TV (Temic 4036FY5 tuner) (Continued)

UHF	122	781.25	33	B0
	123	787.25	34	10
	124	793.25	34	70
	125	799.25	34	D0

PAL TV Tuner

a. PAL (B, G):

Table 8lists the band assignment, video frequencies, and Divider codes for PAL (B, G) broadcast TV for the Temic 4002FH5 Tuner. The actual Divider Bytes for your selected tuner may vary.

Table 8. I²C Divider Bytes for PAL (B,G) Broadcast TV (Temic 4002FH5 tuner)

Band Assignment	Channel Number	Video Carrier (MHz)	Divider Byte 1	Divider Byte 2
	2	48.25	05	72
VHF	3	55.25	05	E2
LOW	4	62.25	06	52
	5	175.25	0D	62
	6	182.25	0D	D2
	7	189.25	0E	42
	8	196.25	0E	B2
VHF	9	203.25	0F	22
HIGH	10	210.25	0F	92
	11	217.25	10	02
	12	224.25	10	72
	21	471.25	1F	E2
	22	479.25	20	62
	23	487.25	20	E2
	24	495.25	21	62
	25	503.25	21	E2
UHF	26	511.25	22	62
	27	519.25	22	E2
	28	527.25	23	62
	29	535.25	23	E2
	30	543.25	24	62
	31	551.25	24	E2
	32	559.25	25	62

Table 8. I 2C Divider Bytes for PAL (B,G) Broadcast TV (Temic 4002FH5 tuner) (Continued)

	33	567.25	25	E2
	34	575.25	26	62
	35	583.25	26	E2
	36	591.25	27	62
	37	599.25	27	E2
	38	607.25	28	62
	39	615.25	28	E2
	40	623.25	29	62
	41	631.25	29	E2
	42	639.25	2A	62
	43	647.25	2A	E2
	44	655.25	2B	62
	45	663.25	2B	E2
	46	671.25	2C	62
UHF	47	679.25	2C	E2
	48	687.25	2D	62
	49	695.25	2D	E2
	50	703.25	2E	62
	51	711.25	2E	E2
	52	719.25	2F	62
	53	727.25	2F	E2
	54	735.25	30	62
	55	743.25	30	E2
	56	751.25	31	62
	57	759.25	31	E2
	58	767.25	32	62
	59	775.25	32	E2
	60	783.25	33	62
	61	791.25	33	E2
	62	799.25	34	62
	63	807.25	34	E2
	64	815.25	35	62

Table 8. I 2C Divider Bytes for PAL (B,G) Broadcast TV (Temic 4002FH5 tuner) (Continued)

UHF	65	823.25	35	E2
	66	831.25	36	62
	67	839.25	36	E2
	68	847.25	37	62
	69	855.25	37	E2

PAL (B, G) Cable TV

Table 9lists the I^2C Divider Bytes for PAL (B, G) Cable TV for the Temic 4002FH5 Tuner. The actual Divider Bytes for your selected tuner may vary.

Table 9. I ^{2}C Divider Bytes for PAL(B,G) Cable TV (Temic 4002FH5 tuner)

Band Assignment	Channel Number	Video Carrier (MHz)	Divider Byte1	Divider Byte 2
	E02	48.25	05	72
VHF	E03	55.25	05	E2
LOW	E04	62.25	06	52
	E05	175.25	0D	62
	E06	182.25	0D	D2
	E07	189.25	0E	42
	E08	196.25	0E	B2
VHF	E09	203.25	0F	22
HIGH	E10	210.25	0F	92
	E11	217.25	10	02
	E12	224.25	10	72
	E21	471.25	1F	E2
	E22	479.25	20	62
	E23	487.25	20	E2
	E24	495.25	21	62
	E25	503.25	21	E2
	E26	511.25	22	62
	E27	519.25	22	E2
	E28	527.25	23	62
UHF	E29	535.25	23	E2
	E30	543.25	24	62
	E31	551.25	24	E2
	E32	559.25	25	62
	E33	567.25	25	E2
	E34	575.25	26	62

Table 9. I 2C Divider Bytes for PAL(B,G) Cable TV (Temic 4002FH5 tuner) (Continued)

	E35	583.25	26	E2
	E36	591.25	27	62
	E37	599.25	27	E2
	E38	607.25	28	62
	E39	615.25	28	E2
	E40	623.25	29	62
	E41	631.25	29	E2
	E42	639.25	2A	62
	E43	647.25	2A	E2
	E44	655.25	2B	62
	E45	663.25	2B	E2
	E46	671.25	2C	62
	E47	679.25	2C	E2
	E48	687.25	2D	62
UHF	E49	695.25	2D	E2
	E50	703.25	2E	62
	E51	711.25	2E	E2
	E52	719.25	2F	62
	E53	727.25	2F	E2
	E54	735.25	30	62
	E55	743.25	30	E2
	E56	751.25	31	62
	E57	759.25	31	E2
	E58	767.25	32	62
	E59	775.25	32	E2
	E60	783.25	33	62
	E61	791.25	33	E2
	E62	799.25	34	62
	E63	807.25	34	E2
	E64	815.25	35	62
	E65	823.25	35	E2
	E66	831.25	36	62

Table 9. I 2C Divider Bytes for PAL(B,G) Cable TV (Temic 4002FH5 tuner) (Continued)

	E67	839.25	36	E2
UHF	E68	847.25	37	62
	E69	855.25	37	E2
	S1	105.25	09	02
	S2	112.25	09	72
	S3	119.25	09	E2
VHF	S4	126.25	0A	52
LOW	S5	133.25	0A	C2
	S6	140.25	0B	32
	S7	147.25	0B	A2
	S8	154.25	0C	12
	S9	161.25	0C	82
	S10	168.25	0C	F2
	S11	231.25	10	E2
	S12	238.25	11	52
	S13	245.25	11	C2
	S14	252.25	12	32
	S15	259.25	12	A2
	S16	266.25	13	12
	S17	273.25	13	82
	S18	280.25	13	F2
	S19	287.25	14	62
	S20	294.25	14	D2
VHF	S21	303.25	15	62
HIGH	S22	311.25	15	E2
	S23	319.25	16	62
	S24	327.25	16	E2
	S25	335.25	17	62
	S26	343.25	17	E2
	S27	351.25	18	62
	S28	359.25	18	E2
	S29	367.25	19	62

Table 9. I ^{2}C Divider Bytes for PAL(B,G) Cable TV (Temic 4002FH5 tuner) (Continued)

	S30	375.25	19	E2
	S31	383.25	1A	62
	S32	391.25	1A	E2
VHF	S33	399.25	1B	62
HIGH	S34	407.25	1B	E2
	S35	415.25	1C	62
	S36	423.25	1C	E2
	S37	431.25	1D	62
	S38	439.25	1D	E2
	S39	447.25	1E	62
UHF	S40	455.25	1E	E2
	S41	463.25	1F	62

Control Code for Various Tuners

The following tables list the Control Bytes and Bandswitch Bytes for various tuners. The actual control codes for your tuner may be different. Check the data sheet of your tuner.

1. NTSC Control Byte and Bandswitch Byte for various tuners:

Table 10. I²C Control and Bandswitch Bytes for Various NTSC Tuners

Tuner Manufacturer	Band Assignment	Control Byte	Bandswitch Byte
	VHF LOW	8E	02
Temic	VHF HIGH	8E	04
4032FY5	UFH	8E	01
	VHF LOW	CE	A0
Philips	VHF HIGH	CE	90
FM1236	UFH	CE	30
	VHF LOW	C2	14
ALPS	VHF HIGH	C2	12
TSCH5	UFH	C2	11

2. PAL Control Bytes and Bandswitch Byte for various tuners:

Table 11. I²C Control and Bandswitch Bytes for Various PAL Tuners

Tuner Manufacturer	Band Assignment	Control Byte 1	Bandswitch Byte 2
	VHF LOW	8E	02
Temic	VHF HIGH	8E	04
4002FH5	UFH	8E	01
	VHF LOW	CE	A0
Philips	VHF HIGH	CE	90
FM1246	UFH	CE	30
	VHF LOW	C8	05
ALPS	VHF HIGH	C8	02
TSBE1	UFH	C8	08

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