OCR
RECOGNISING ACHIEVEMENT

GCE

Electronics

Advanced GCE

Unit **F615:** Communications Systems

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

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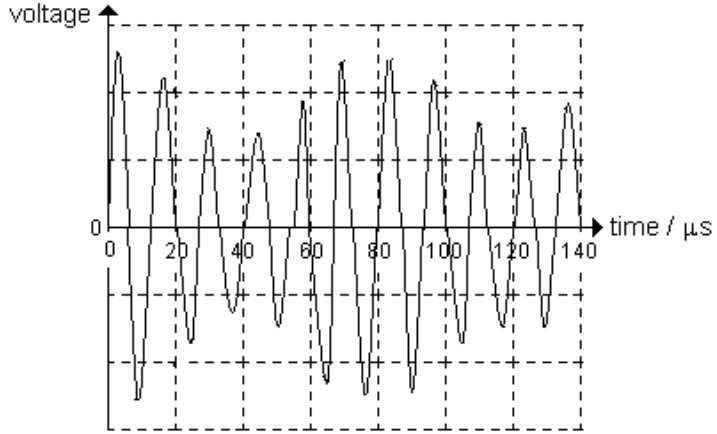
This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

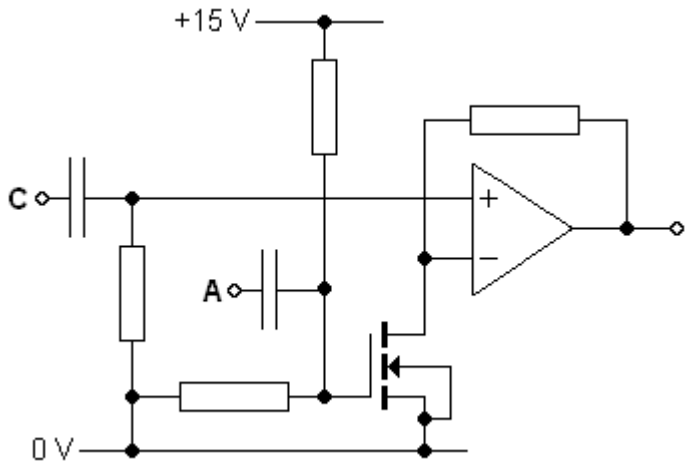
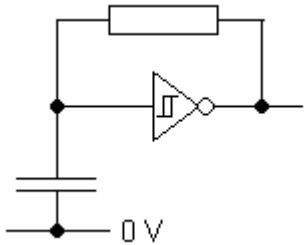
All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

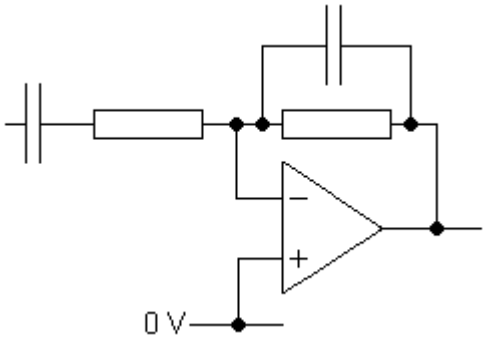
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

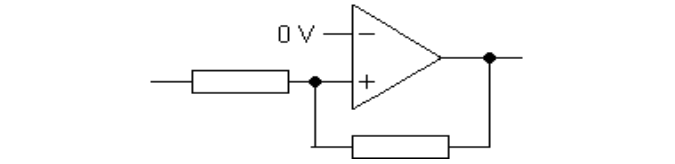
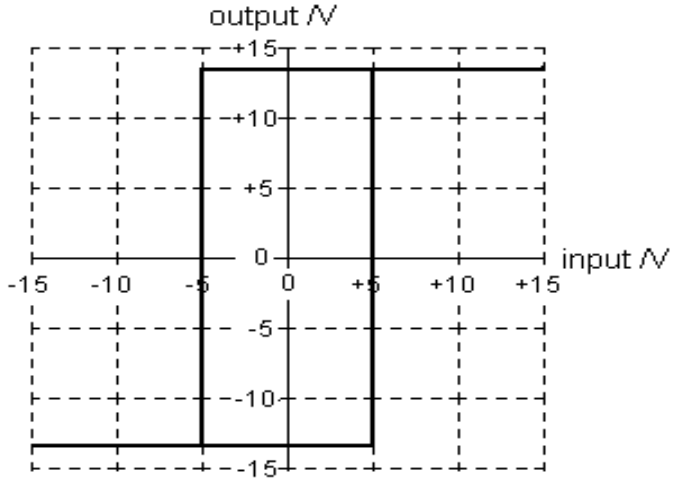
OCR will not enter into any discussion or correspondence in connection with this mark scheme.

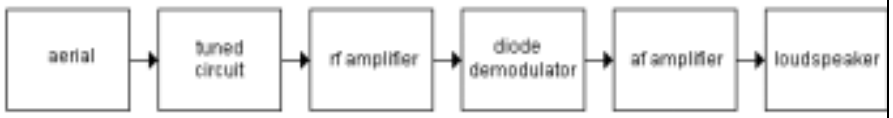
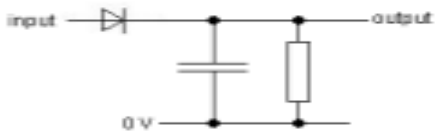
Question			Answer	Marks	Guidance
1	(a)		number of levels = 1.27/0.01 + 1 = 128; 2^7 = 128;	1 1	**accept** 1.27/0.01 (=127 levels) **accept** reverse calculation e.g. $\log_2 128 = 7$ etc.
	(b)	(i)	pixel rate = 1024000 × 60 = 6.1×10^7 s^{-1}; bandwidth = 0.5 × 6.1×10^7 = 30.7 / 31 MHz;	1 1	**look for** calculation/explanation for each step **accept** reverse calculation: 5 MHz gives $1x10^7$ bps; refresh rate = 9.8 Hz / pixel rate = $1.7x10^3$ s^{-1}; **ecf** bandwidth from incorrect pixel rate
		(ii)	fine detail of picture would be lost / image out of focus; as higher frequencies of video signal would not get through;	1 1	**not just** poor picture quality
		(iii)	EITHER assuming lbw cable refresh rate would need to be reduced; to 10 Hz / if went below 25 Hz; and image would flicker; OR assuming hbw cable allows high refesh rate; above 25 Hz; to avoid flicker	 1 1 1	 **accept** anything from 20 Hz to 30 Hz
		(iv)	rows = 1024000/1280 = 800; frequency = 60 × 800 = 48 kHz;	1 1	 **no ecf**

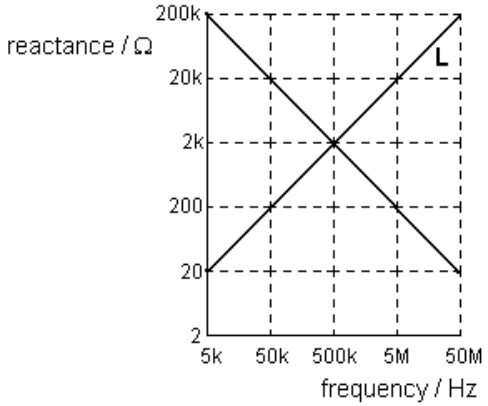
Question			Answer	Marks	Guidance
2	(a)	(i)	75 kHz	1	
		(ii)	13 kHz	1	
	(b)			3	any sinusoidally modulated carrier centred on 0 V [1] **accept** high frequency fuzz for carrier **accept** just envelope lines for modulated carrier **ignore** envelope lines otherwise two cycles of modulation across screen [1] 9 - 13 cycles of carrier across screen [1] any amplitude, any depth of modulation

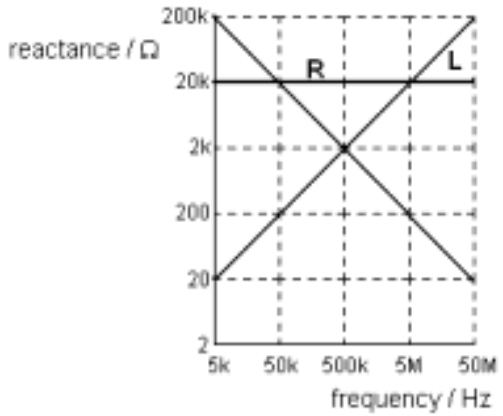
Question			Answer	Marks	Guidance
	(c)	(i)		1	both labels correct for [1] **accept** carrier for C and a.f. signal for A
		(ii)	any four from: • potential divider biases (owtte) a.f. signal • mosfet resistance varied • by (a.f.) signal at gate; • op-amp connected as non-inverting amplifier; • amplifying carrier signal; • with gain depending on resistance of mosfet;	4	**not just** identifies bias network
		(iii)		4	correct circuit, including ST NOT gate [1] R at least 1 kΩ [1] RC = 27 μs (ecf from a(i)) [1] **accept** anything which rounds to 27 μs use of $T = 1/f$ and $T = 0.5RC$ [1] **not** astable, crystal oscillator **accept** enable diode at ST input

Question			Answer	Marks	Guidance
3	(a)	(i)		8	non-inverting input to 0 V (accept via resistor) [1] effective treble cut circuit [1] effective bass cut circuit [1] all resistors between 1 kΩ and 1MΩ [1] R_F / R_{IN} = 30 [1] input RC = 1.1 ms [1] **accept** 1 ms feedback RC = 11 μs [1] **accept** 10 μs quote and use of $f_0 = \frac{1}{2\pi RC}$ to justify value(s) [1] **accept** two filters in series for full marks
		(ii)	bandwidth = 5 × maximum signal frequency; 15 × 5 = 75 kHz;	1 1	**ecf** 750 Hz, 74 kHz [1] 7.5 kHz [0] **no ecf** on incorrect rule
		(iii)	EITHER prevent interfering with neighbouring channels; OR narrow bandwidth allows more channels; OR their broadcasting licence specifies frequencies allowe to use	1	**look** for idea of neighbouring stations in spectrum
	(b)		any three of the following, [1] each: • frequency at output is variable; • depends on voltage at (a.f.) input; • frequency changes linearly with voltage; • amplitude at output does not change; • frequency is 75 kHz for no signal at input;	3	**accept** voltage-frequency graph for full marks **not** amplitude / signal for voltage

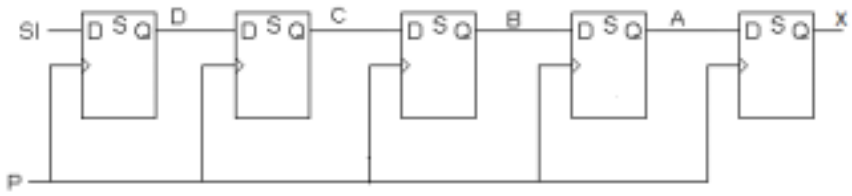
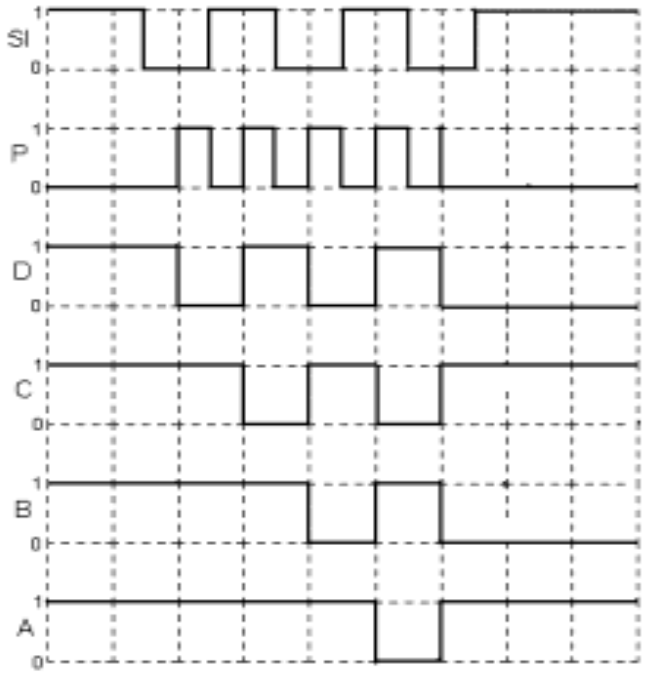
Question			Answer	Marks	Guidance
4	(a)		 	4	correct circuit for [1] correct shape of graph for non-inverting ST [1] **not just** a square output only changes at trip points of ±5 V [1] output only at ±13 V [1] **accept** from 14 to 12 **ignore** arrows on graph
	(b)		values from graph; use of $\Delta V_{out} = -V_{in}\frac{\Delta t}{RC}$; R from 1 kΩ to 1 MΩ; RC = 39 μs;	1 1 1 1	look for sensible substitution e.g. $-10 = -13 \times \frac{30 \times 10^{-6}}{RC}$ **no ecf** for incorrect values from graph **accept** correct answer and no working for [4]
	(c)		any three of the following: • amplitude must be less than 5 V; • or comparator output does not change; • frequency must be less than $1/120 \times 10^{-6}$ = 8.3 kHz; • to get at least two samples per cycle;	3	wa

Question			Answer	Marks	Guidance
5	(a)		noise is random signal; from materials in the link / processors; interference is unwanted signal picked up by receiver; from other electrical systems / signals;	1 1 1 1	 **accept** picked up during transmission owtte **accept** interference is non-random **accept** example of a source of interference
	(b)		cables carry signal and its inverse; both cables pick up the same interference; which is rejected by difference amplifier in receiver; noise from cables doesn't cancel (in difference amplifier);	1 1 1 1	**accept** voltage, current for signal **ignore** references to shielding, random noise
	(c)		restores signal to high and low; removing information about amplitude (of incoming signal);	1 1	**accept** square wave output **not** just removes noise **ignore** references to frequency
6	(a)			5	[1] per correct block
	(b)	(i)		3	input in series with diode [1] capacitor in parallel with resistor to 0 V / ground [1] inputs and outputs labelled [1]
		(ii)	any three of the following, [1] each: • diode (and resistor) rectify signal (owtte); • to generate af signal; • capacitor and resistor filter; • to eliminate rf signal (owtte);	3	 **accept** negative parts of signal **accept** capacitor and resistor smooth signal **not** just sidebands

Question			Answer	Marks	Guidance
	(c)		Increase the length of the aerial. ✓ Increase the gain of the rf amplifier. ✓ Decrease the gain of the af amplifier. Increase the impedance of the loudspeaker. Reduce the break frequency of the diode detector.	2	completely correct for [2] one mistake for [1]
7	(a)	(i)	$X_L = 2\pi \times 640\times10^{-6} \times 50\times10^{3}$; = 201 Ω;	2	substitution [1] **accept** 640μ, 50k evaluation for [1]
		(ii)		2	straight line through 200 Ω, 50 kHz [1] gradient of 45 degrees [1] **accept** missing label

Question			Answer	Marks	Guidance
		(iii)		1	
	(b)		each LC circuit must have a different (resonant) frequency f_0; to create better filter than simple LC circuit; so that only one carrier + sidebands gets through;	1 1 1	**accept** centre frequency for f_0 **accept** labelled gain-frequency graphs **accept** to improve selectivity
	(c)		X is a buffer/amplifier/MOSFET follower; any two of the following: • X has a high impedance input; • which reduces current drawn from LC circuit ; • so that it is not affected / loaded by the next one;	1 2	**not** op-amp **accept** voltage follower **accept** next stage has not got high (input) impedance **ignore** increases amplitude of signal **accept** not affecting its selectivity / bandwidth

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>8</td><td>(a)</td><td></td><td>V = 5 - 1.5 = 3.5 V;
R = 3.5/2×10^{-3} = 1750 Ω;</td><td>1
1</td><td>
accept 1.8 kΩ
ecf:: 1.5 V gives 750 Ω, 4.5 V gives 2250 Ω [1]
accept 5 - 2.1 = 2.9 V gives R = 1.45 kΩ [1]
5/2×10^{-3} = 2.5 kΩ [0]</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>$B = \overline{W}.X + \overline{X}.\overline{Y}$ for [2]
$B = \overline{(\overline{W}.X).(\overline{X}.\overline{Y})}$ for [1]</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><th>input signal</th><th>W</th><th>X</th><th>Y</th><th>B</th><th>A</th></tr><tr><td>0.25 V</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0.75 V</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1.25 V</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td></tr><tr><td>1.75 V</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td></tr></table></td><td>4</td><td>[1] per correct column
ecf on incorrect W, X, Y: $B = \overline{W}.\overline{X}.\overline{Y} + \overline{W}.X.Y$
no ecf from (b)(i)</td></tr>
<tr><td></td><td>(c)</td><td></td><td>number of levels = (2$^{\text{word length}}$ =) 2^2 = 4;
resolution = range/number of levels = 2.0/4 ;</td><td>1
1</td><td>accept words, codes for levels
accept reverse argument
look for explanation and calculation for each mark</td></tr>
<tr><td></td><td>(d)</td><td></td><td>time for one cycle = 2 x 15x10^{-6} = 30×10^{-6} s;
frequency = 33 kHz;</td><td>1
1</td><td>accept 67 kHz for [1]</td></tr>
</table>

Question			Answer	Marks	Guidance
9	(a)		0/start bit alerts receiver that a new word is about to arrive; 1/stop bit sets line so that the next 0/start bit can be detected;	1 1	**accept** sets the bistable / enables the clock **not** to signal end of word
	(b)		2048 × 6 ; = 12 288 Hz or 12.3 kHz;	1 1	**accept** 2048 × 4 = 8.19 kHz for [1]
	(c)			3	Q to following D throughout [1] clocks in parallel to P [1] **accept** CK, clock for P SI and DCBAX correctly labelled [1] **accept** serial input for SI
	(d)			4	each correct row for [1]

APPENDIX 1

Quality of Written Communication

3	The candidate expresses complex ideas extremely clearly and fluently. Sentences and paragraphs follow on from one another smoothly and logically. Arguments are consistently relevant and well structured. There will be few, if any, errors of grammar, punctuation and spelling.
2	The candidate expresses straightforward ideas clearly, if not always fluently. Sentences and paragraphs may not always be well connected. Arguments may sometimes stray from the point or be weakly presented. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.
1	The candidate expresses simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weaknesses in these areas.
0	The language has no rewardable features.

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